PROJECT MANUAL FOR

NEW ARNOLD HOUSE #1
ROCK TOWNSHIP AMBULANCE DISTRICT
2455 HICKORY SQUARE PARKWAY
ARNOLD, MISSOURI 63010

NEW FENTON HOUSE #2
ROCK TOWNSHIP AMBULANCE DISTRICT
2250 KONERT ROAD
FENTON, MISSOURI 63026

OWNER:

ROCK TOWNSHIP AMBULANCE DISTRICT
6707 ST. LUKE’S CHURCH ROAD
BARNHART, MISSOURI  63012

DOCUMENT DATE: JANUARY 30, 2020

PRE BID CONFERENCE: FEBRUARY 6, 2020
3:00 P.M.

BID OPENING: FEBRUARY 26, 2020
3:00 P.M.

FGM NO.: 19-2726.01 ARNOLD
19-2727.01 FENTON

SET NO.:
## Specifications

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- **New Arnold House #1**
- **New Fenton House #2**

- **Rock Township Ambulance District**
- **Rock Township Ambulance District**

- **2455 Hickory Square Parkway**
- **2250 Konert Road**

- **Arnold, Missouri 63010**
- **Fenton, Missouri 63026**

**FGM Project No.:** 19-2726.01

**FGM Project No.:** 19-2727.01

**Date:** January 30, 2020

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Specifiers:

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END TOC.
SECTION 22 00 00 – PLUMBING GENERAL CONDITIONS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.

B. Should a conflict arise between Section 220000 General Conditions and other Sections, the General and Supplementary Conditions of Division 1 shall take precedence.

C. The plumbing work shall comply with all provisions of the architectural, plumbing, fire protection, mechanical and electrical drawings and specifications.

D. The word "Contractor" as used in these specifications shall be held to mean the person, firm or corporation contracting to do the herein described work.

E. It shall be a part of this Contractor's bid that the submission of a proposal carries with it the agreement to all items and conditions referred to in the specifications and accompanying drawings.

F. Rough-in for and connect, as shown on the drawings, facilities for equipment furnished by the Owner under a separate contract.

1.2 RULES AND REGULATIONS

A. The rules, regulations, ordinances of all applicable governing bodies in force at the time of execution of the Contract shall become a part of these specifications. These shall include the requirements of state, county, city and also the local utility companies.

B. All materials furnished and work performed shall be in compliance with the latest applicable version of the following codes:

   - International Building Code - 2015
   - International Plumbing Code - 2015
   - International Mechanical Code - 2015
   - International Fuel Gas Code - 2015
   - National Electrical Code - 2008
   - ASHRAE STANDARD 90.1 –
   - International Fire Code - 2015

1.3 PERMITS AND FEES

A. Cost of all fees, permits or licenses that may be required for the performance of the Contract shall be included.

1.4 PLANS AND SPECIFICATIONS

A. The specifications and the accompanying plans (architectural, structural, mechanical, electrical, fire protection and plumbing) are mutually explanatory and anything described or
shown on one, but not on the other, shall be considered as if shown or described on both. The intention of the plans and specifications is to provide complete functioning systems in every respect. Contractor shall furnish all material and equipment and shall perform all labor to achieve this intent, whether or not such material or equipment is indicated herein. Whenever the term "provide" is used, it shall mean "furnish and install." If a conflict exists between the drawings and the specifications or between one specification and another specification or between one drawing and another drawing, the most demanding requirement shall apply unless otherwise authorized in writing by the Engineer.

B. Data given herein and on the drawings is as exact as could be secured. Their absolute accuracy is not guaranteed and this Contractor shall obtain and verify exact locations, measurements, levels, space requirements, etc., at the site, and shall satisfactorily adapt the work to actual conditions at the building as constructed.

C. The drawings shall be considered schematic and are not intended to indicate all changes in direction and necessary fittings to be installed by this Contractor. Piping, equipment, etc., shall be installed so all items clear the structure and other building elements and maintain appropriate clearances for access, service and maintenance.

D. Some of the details on the plans are schematic or diagrammatic. These details are not intended to show all pipe, fittings, etc., required to achieve the arrangement shown on the plan view, but instead are intended to show those items, such as pipe arrangement, fittings, specialties, etc., which are not shown on the plan view. This Contractor shall appropriately adapt these details to the actual conditions of the job.

E. Routing of piping, location of equipment, and location of other devices are shown on plans for general guidance. This Contractor shall coordinate his work with other Contractors and shall provide necessary deviations in routing as far as 10 feet from those shown to provide systems as specified or implied, without interference and pursuant to these requirements at no additional cost to the Owner, Architect or Engineer.

F. Contractor shall not scale the drawings. Refer to architectural and structural drawings for building construction and dimensions and to room finish schedule on architectural drawings for material, finish and construction method of walls, floors and ceilings in order to insure proper rough-in and installation of contractor’s work.

G. Changes, modifications or variations to the plans and specifications will be issued by the Engineer in writing.

1.5 DISCREPANCIES OR OMISSIONS

A. During the bidding period, should a bidder find discrepancies or omissions in any of the documents or should he be in doubt as to their meaning, he should at once notify the Engineer who will, time permitting, issue a written instruction in the form of an addendum to all bidders of record. The Engineer will not be responsible for any oral explanations or interpretations of the documents.

B. During construction, should a discrepancy or omission be found, it shall be brought to the attention of the Engineer at once for resolution.
C. No changes in contract price will be allowed for minor changes in layout or location required to avoid interferences, obstructions, etc. Contract price changes will be considered only for changes in the scope of the project requirements. All such scope changes and price revisions must be authorized in writing.

D. If discrepancies are found within the contract documents, the most demanding requirement shall take precedence unless otherwise agreed by the engineer in writing.

1.6 HOISTING

A. Contractor shall be responsible for hoisting of all materials and equipment furnished or installed under this Section of the Specifications, in accordance with all city, state and federal rules and regulations.

1.7 SHOP DRAWINGS

A. Contractor shall submit shop drawings in compliance with the General and Special Conditions. Contractor shall field verify exact locations, measurements, and space availability at the site, etc. prior to fabricating materials and shall notify the Engineer of discrepancies in writing.

B. The Contractor shall submit copies of all required Shop Drawings and material and equipment lists.

C. Submittals shall be transmitted to SSC Engineering as paper documents, electronic documents via email attachments, or electronic documents via FTP file transfers.

1. All submittals shall include a transmittal form identifying the project name, date, contents of submittal package, and names of subcontractor, manufacturer, and supplier.

2. On an attached separate sheet clearly identify deviations from requirements in the Contract Documents, including minor variations and limitations.

3. Paper submittals shall be sent to

   SSC Engineering
   Attention: Submittals
   18207 Edison Ave.
   Chesterfield, MO 63005

4. Emails regarding submittals shall be sent to “submittals@sscengineering.com”.

D. Documents transmitted in paper format shall be sent to the Architect who will forward these to SSC. If approved by the Architect prior to submitting documents, these documents may be submitted simultaneously to the Architect and SSC. SSC will return all documents to the Architect only regardless of how they were transmitted to SSC. Submit four (4) paper copies of all required Shop Drawings and material and equipment lists for the Engineer’s and Owner’s sole use. The Contractor shall submit additional paper copies that will be required for his own use and the Operation and Maintenance Manuals. The additional copies will be reviewed by the Engineer and returned to the Contractor marked accordingly.

E. If SSC is the prime consultant and there is no Architect, paper documents shall be transmitted directly to SSC.
F. Documents transmitted as email attachments shall be sent simultaneously to the Architect and SSC. SSC will return one (1) electronic copy of these documents to the Architect only.

G. Documents transmitted via FTP file transfers shall be retrieved from the FTP site after SSC has received an email notification that these documents have been posted to the site. SSC will return one (1) electronic copy of these documents to the Architect only unless another procedure is agreed to in writing by the Architect and the Engineer.

H. Contractor shall review and correct all shop drawings before they are submitted. Shop drawings shall bear the signed and dated approval stamp of this Contractor.

I. Shop drawings shall include the plan mark used on the plans.

J. Valve and fitting shop drawings shall indicate the intended service.

K. Equipment shop drawings shall give capacities at conditions specified and shall include manufacturer's catalog numbers and cuts. Shop drawings shall be clearly marked; shall indicate all accessories, items, conditions, etc., which are being furnished; and shall indicate that all conditions of the plans and specifications are being met. Wiring diagrams shall be submitted.

L. Submittals which do not provide the required information will be returned unchecked.

M. Contractor shall be responsible for deviations, errors and omissions, quantities, and coordination dimensions in submittals, and this responsibility shall not be relieved by Engineers' review of submittals.

N. This Contractor shall coordinate each submittal with the contract documents, work of other contractors, and job site conditions.

O. The Contractor shall not be relieved of responsibility for deviations from requirements of the Contract Documents by the Engineer's approval of Shop Drawings, Product Data, Samples or similar submittals unless the Contractor has specifically informed the Engineer in writing of such deviation at the time of submittal and (1) the Engineer has given written approval to the specific deviation as a minor change in the Work, or (2) a Change Order or Construction Change Directive has been issued authorizing the deviation. The Contractor shall not be relieved of responsibility for errors or omissions in Shop Drawings, Product Data, Samples or similar submittals by the Engineer’s approval thereof.

1.8 RELEASE OF CAD FILES

A. See “Release of Cad Files” at the end of this section.

1.9 MAINTENANCE AND OPERATING INSTRUCTIONS AND MANUALS

A. Upon completion of the job, the installing contractors and major suppliers shall instruct the Owner's representatives in the proper operation and maintenance of the systems installed. The installing Contractors shall submit documentation indicating the date of instruction; names and organization of persons providing and receiving the instructions; systems the instructions covered; and materials received.
B. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

1. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.

2. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.

C. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.

D. Contractor shall also submit four (4) complete hard copy sets and one (1) electronic copy of properly bound operating manuals to the Engineer for review. These manuals shall include the following:

1. Complete set of shop drawings.
2. Copies of all submittals.
3. Parts lists, wiring diagrams, piping diagrams, etc.
4. Manufacturers' operating and maintenance instructions.
5. As-built drawings.
6. Written operating and maintenance instructions for the system.
8. Parts list for each piece of equipment and name of local supplier.

E. At a predetermined time, prior to building occupancy, an instructional session shall take place. The installing contractors and major suppliers shall instruct the Owner's operating personnel on operation and maintenance of the systems. The installing Contractor shall submit documentation indicating the date of instruction; names and organization of persons providing and receiving the instructions; systems the instructions covered; and materials received.

1.10 RECORD DRAWINGS

A. During construction, a separate set of plans at the jobsite shall be maintained by the Contractor to keep a record of all changes of locations. See additional requirements in General Conditions and Supplementary Conditions.

B. Locations of piping, specialties and other concealed facilities are to be shown by the Contractor if and when they differ from the drawings. Underground piping shall be dimensioned on those drawings.

C. "As built" drawings are to be submitted to Architect/Engineer for review prior to the time of request for final payment. Submit as-built record drawings in accordance with the General Conditions.
D. For drawings that SSC has furnished to the contractor in CAD format, contractor shall prepare “As Built” drawings in CAD format. "As built" drawings in CAD format are to be submitted to Architect/Engineer, in addition to marked up paper documents for review prior to the time of request for final payment. Submit as-built record drawings in accordance with the General Conditions.

1.11 WORKMANSHIP AND MATERIALS

A. All work shall be performed in a manner acceptable to the Engineer, Architect, and the Owner, by properly trained, supervised and experienced personnel using new and clean materials, supplies, equipment, and hardware.

1.12 MATERIAL AND EQUIPMENT HANDLING AND STORAGE

A. It is recognized that space at the project for storage of materials and products is limited. Coordinate the deliveries of materials and products with the scheduling and sequencing of the work so that storage requirements at the project are minimized. In general, do not deliver individual items of equipment to the project substantially ahead of the time of installation.

1.13 GUARANTEE AND WARRANTY

A. This Contractor shall guarantee and warrant all equipment, materials, workmanship, installation, etc., for a period of one year from final acceptance in accordance with the General Conditions.

B. During the guarantee period, this Contractor shall make all required repairs and replacements, and shall provide all necessary service, labor, tools, materials, parts, etc., required during this period at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 MATERIAL SUBSTITUTION

A. Equipment selection has been based on one manufacturer to establish the desired type, style, quality, performance, etc. When other manufacturers are listed as equally acceptable, the product of those manufacturers will be accepted if their product complies with these specifications and drawings. The listing of a manufacturer does not relieve that manufacturer from complying with the specifications and drawings.

B. All equipment and materials are subject to the review and approval of the Engineer and Architect.

C. All differences in cost involved in using an equally acceptable manufacturer shall be included in this Contractor’s bid. This contractor shall be responsible for any and all engineering and installation variations due to the substituted equipment. These include structural, electrical, architectural, plumbing, mechanical, fire protection, etc. changes.

D. Deviations from these specifications are not solicited and are not encouraged. If a deviation between the specifications or drawings and items bid does exist, then that deviation must be clearly itemized and explained on the bid form.
E. Solvent based adhesives or sealants shall not be substituted for water based adhesives or sealants.

PART 3 - EXECUTION

3.1 GENERAL

A. Contractor shall furnish all material, equipment, labor, services, supplies, etc., required to execute to completion all work shown on the plumbing drawings, described in these specifications, or made necessary by the work shown on the drawings and/or described in these specifications.

B. This Contractor shall schedule all work and furnish the required materials in such a manner that the work may progress from start to finish in an expeditious and efficient manner without undue interruption. This Contractor shall also schedule his work to coordinate with the construction staging for this project.

C. Contractor shall hire the proper trades to accomplish the work described on the drawings or in the specifications.

3.2 COORDINATION OF TRADES

A. Prior to the fabrication or installation of any materials, this Contractor shall review the drawings indicating work to be performed by each trade. If conflicts occur, they shall be brought to the attention of the Engineer for resolution.

B. If this Contractor installs the work without coordinating with the other trades, then, if requested by the Owner, Architect, or Engineer, this Contractor shall remove and rework some installed work to resolve a conflict, and such change shall be done at no change in contract price.

C. The Contractor supplying the equipment shall furnish all motors and components which are part of the equipment.

D. Control wiring is defined as that wiring which conducts electrical energy at a voltage of less than 100 volts. Interlock wiring is defined as that wiring which performs a control function, but at a voltage of 100 volts or greater. All other wiring shall be considered power wiring.

E. The Electrical Contractor shall furnish and install all power wiring to, and including connection to the equipment. Unless specifically noted otherwise, all interlock wiring shall be furnished and installed by the Electrical Contractor. Unless noted otherwise, the control wiring shall be furnished and installed by the Contractor furnishing the controlled equipment.

F. Unless noted otherwise, the Electrical Contractor shall furnish and install all starters, disconnects, switches, push-button stations, etc., except those which are furnished with the equipment as a part of a factory-assembled package.

3.3 PROTECTION OF EQUIPMENT AND WORK
A. This Contractor shall, at all times, protect and preserve all materials, supplies, equipment, piping, etc., from damage due to weather, corrosion, dirt, vandalism, theft, etc., and shall further provide all enclosures or special protection as indicated by circumstances.

B. Should any of the materials, equipment, etc., be damaged as a result of his negligence, then this Contractor shall be held responsible for all such damage and costs incurred for repair or replacement.

3.4 CONSTRUCTION STAGING

A. See schedule in Division 0 and Division 1. This Contractor shall cooperate with and coordinate with the Owner’s Representative to plan and schedule the work to satisfy the schedule.

B. All work shall be so arranged that electrical power, sewer, water, and other services are available to the building at all times, except for short periods of interruption necessary for the performance of new work. Interruptions shall not be requested until the new services are complete and ready for final connection.

C. All interruptions shall be scheduled, and services shall not be interrupted without written approval of the Owner’s Representative. Notification to the Owner’s Representative shall include the exact time and estimated duration of any interruption.

D. Pipes which are shown to be installed or demolished in subsequent phases that are needed for earlier phases to make the earlier phase operational shall be installed or demolished in the earlier phase during non-business hours. Where later phase work is performed in an earlier phase, contractor shall remove and replace ceilings as required to perform the work.

3.5 MAINTENANCE OF WORK AREAS

A. During the project this Contractor shall maintain his work area in an organized manner, shall not allow debris to accumulate, and shall store equipment, tools and supplies in a manner which shall not cause interference with the activities of others engaged on the project.

B. Open ends of pipe, equipment and specialties shall be kept properly closed during construction and installation so as to avoid contamination.

3.6 CLEANING AND CLEANUP

A. Upon completion of this work, the Contractor shall clean all pipe, fixtures, and equipment. Contractor shall leave all work in a finished, clean, and satisfactory working condition.

B. This contractor shall be responsible for his own cleanup to a central location designated by the Owner and General Contractor. Contractor shall periodically remove all rubbish, crating, unused material, outfall, and any other debris created by him during the course of the work.

END OF SECTION 220000
RELEASE OF CADD FILES

The drawings prepared by SSC Engineering have been prepared using AUTOCAD 2018. Files for plan drawings prepared by SSC Engineering will be made available to the successful HVAC, plumbing, electrical and fire protection contractor by email; no other drawings will be released. The files will have background files bound in, borders and title blocks removed, and all notes, details, diagrams, and schedules removed. A release form must be signed. Utilization of these documents for the development of shop drawings and submittals does not relieve the contractor from any of his responsibilities herein.

Release form that must be signed:

As requested, SSC Engineering will provide ______________________ (name of contractor) with electronic CADD files of the requested (M, E, P, FP) floor or ceiling plans on the terms set forth below. While SSC is not required under its contract to provide or update these electronic files for this purpose, they are being made available as a convenience to the contractor and as a substantial time saver in the preparation of submittals for this project.

The files contain information through the date when the drawings were issued for bidding and may or may not contain information from the addenda. The company using these files shall be responsible for the coordination of the information contained therein with the Plans, Specifications and other Contract Documents. In the event of any ambiguity, discrepancy or conflict between the information within the electronic files and the Contract Documents, the Contract Documents shall be used.

SSC will not be responsible for any error or malfunction in the translation, interpretation or use of this electronic information once it has been provided to the contractor. SSC does not assume any responsibility arising out of the use or adaptation of the information contained in these files or the sufficiency of any drawings prepared based upon the information included within. By accepting these drawing files, the contractor agrees to hold the Engineer harmless with regard to any errors or omissions in the drawing files. Nothing included in this release shall modify any requirements or responsibilities of either party under their respective contracts.

Signing below indicates understanding and acceptance of these terms. Upon receipt of a signed letter or fax, SSC will release the electronic CAD files.

Project Name and Number: ______________________________________________________

Specific Drawings Request: ______________________________________________________

Acknowledged and Agreed:

__________________________________ ________________________________
Company Version of AutoCAD used

__________________________________ ________________________________
Name (Must be an officer of the Company) E-mail address

__________________________________ ________________________________
Title Maximum e-mail attachment size

__________________________________ ________________________________
Date
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SECTION 22 00 10 - BASIC PLUMBING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 WORK INCLUDED

   A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.
   
   B. Section 220000 - Plumbing General Conditions.
   
   C. This section covers basic plumbing materials and methods for Plumbing work and applies to work of those sections.

1.2 SUBMITTALS

   A. This Contractor shall submit shop drawings on all material or equipment furnished by him or his Subcontractors. Manufacturer's technical product data and installation instructions shall be submitted on:

      1. All Supports
      2. Pipe Seals and Pipe Stands
      3. Sealants
      4. Pipe Markers

PART 2 - PRODUCTS

2.1 PRODUCT CRITERIA

   A. Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product for at least 5 years.
   
   B. Products shall be supported by a service organization which maintains an inventory of repair parts and is located within 100 miles of the jobsite.

2.2 MATERIALS AND STANDARDS

   A. All equipment and materials furnished by this Contractor shall be new, and where two or more items of the same kind are required, they shall be the product of the same manufacturer.

   B. All materials, equipment, operations, procedures and installation of all materials and equipment shall conform to:

      ADA        Americans with Disabilities Act
      ASME       American Society of Mechanical Engineers
      UL         Underwriters' Laboratories, Inc.
      NFPA       Applicable sections of the National Fire Protection Association
      NEMA       National Electrical Manufacturers Association
      OSHA       Occupational Safety and Health Administration
      NEC        National Electrical Code
      AMCA       Air Moving and Conditioning Association
      ASHRAE     American Society of Heating, Refrigeration and Air Conditioning Engineers
C. All materials used shall be applied in compliance with the manufacturer's recommendations. If a discrepancy occurs between the application of materials as called for on the drawings or in the specifications and the manufacturer's recommendations, this discrepancy shall be called to the Engineer's attention before materials are purchased or applied.

2.3 PREFABRICATED PIPE SEALS

A. Seals for Roof Penetrations:
   1. Prefabricated pipe seals shall have a one piece spun aluminum base with a 5" high roof surface flange sloped for runoff. Unit shall have a PVC boot with graduated widths and adjustable stainless steel clamps. Unit shall withstand expansion, and vibration and shall fit pipe sizes from ½" through 10" be heavy-gage, galvanized steel curb with mitered and welded corners; 1-1/2-inch-thick
   2. Equal products, complying with these specifications by the following manufacturers are acceptable:
      a. Pate
      b. Roof Products & Systems
      c. Thycurb
      d. Approved Equal

B. Seals for Floor or Foundation Wall Penetrations:
   1. Mechanical Seal: Link-Seal or approved equal. A modular mechanical sealing assembly consisting of interlocking rubber links shaped to fill the annular space between the pipe and sleeve; corrosion-protected carbon steel bolts, nuts, and pressure plates. After the assembly is positioned in the sleeve, tightening the bolts shall cause the rubber links to provide a watertight seal between the pipe and the sleeve. Seal assembly shall be sized as recommended by the manufacturer. Provide sleeves of proper diameters.

2.4 FLASHING

A. Metal Flashing: 26 gage galvanized steel.

B. Lead Flashing: 5 lb/sq ft sheet lead for waterproofing; one lb/sq ft sheet lead for soundproofing.

C. Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing.
D. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.5 MISCELLANEOUS MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36. Interior applications shall be galvanized steel or black steel. Exterior applications shall be galvanized steel.

B. Strut systems shall be painted steel equal to B-Line Systems or Unistrut. Where used in exterior applications, the materials shall be galvanized steel.

2.6 SLEEVES

A. Exterior and Foundation Walls: All piping through exterior or foundation walls shall pass through schedule 40 galvanized steel sleeves which shall be large enough to allow for caulking material. No sleeves are permitted through concrete structural members unless indicated on the structural drawings or approved by the Engineer.

B. Interior Walls and Partitions: All piping through interior walls and partitions that are fire rated shall pass through either schedule 40 black steel or 20 gauge galvanized steel sheet metal sleeves. Schedule 40 steel pipe sleeves must be used when required for structural purposes. Sleeves are not required for automatic control tubing.

C. Floors: All piping through elevated floor slabs shall be provided with schedule 40 carbon steel pipe sleeves, extending 2 inches above floor except in finished areas. Sleeves in finished areas shall terminate flush with floor, and shall be schedule 40 carbon steel pipe.

2.7 BACKING & SEALANTS

A. Backing and sealant for piping passing through floors, plaster ceilings, partition, and walls shall be as follows:

1. Backing Material:
   a. A pure ceramic fiber made of alumina-silica; "Cerafiber- FS" by Manville or equal.
   b. Insulation: Glass fiber type, non-combustible.

2. Sealant: Gun Grade. An 1-part modified polyurethane, gun applied, elastic sealant, "Dymonic" by Tremco, or Chem-Calk 900 by Bostik.

3. Mechanical Seal: Link-Seal or approved equal. A modular mechanical sealing assembly consisting of interlocking rubber links shaped to fill the annular space between the pipe and sleeve; corrosion-protected carbon steel bolts, nuts, and pressure plates. After the assembly is positioned in the sleeve, tightening the bolts shall cause the rubber links to provide a watertight seal between the pipe and the sleeve. Seal assembly shall be sized as recommended by the manufacturer. Provide sleeves of proper diameters.

4. Fire Retardant Sealants: Products used shall be U.L. Classified and approved for the application. Products shall produce non-toxic fumes and shall be PCB and asbestos free. Subject to compliance with requirements, provide fire retardant sealant products from one of the following:
2.8 FIRE PROOFING ON STRUCTURE
   
   a. Where fire proofing is existing or has been applied to the structure by others and the work of this contractor damages or removes this fire proofing while making attachments to the structure, this contractor shall include cost to repair the fire proofing to its original condition.

2.9 LINTELS
   
   a. Unless otherwise indicated on plans, all lintels required for the support of building construction above pipes, equipment, etc., shall be furnished and installed by this Contractor.
   
   b. Lintels furnished shall be structural steel angles, channels, or tees of proper size and sections for the load being supported.

2.10 CUTTING
   
   a. All openings for pipes etc., shall be provided by this Contractor by means of sleeves or framed openings.
   
   b. Cutting shall be limited to the size necessary for working conditions. When cutting surfaces are difficult or costly to replace, such as marble, glazed tile, wood paneling, etc., this contractor shall obtain the Owner’s approval in advance of the cutting and patching.
   
   c. Contractor shall be responsible for any cutting required for pipes, etc., if sleeves or openings are not properly provided. Under no circumstances shall any structural members, load bearing walls, or footings be cut without first obtaining written permission from the Structural Engineer. All cutting and patching shall be done at the expense of the contractor requiring the cutting.
   
   d. Prior to cutting or core drilling of structural concrete slabs, contractor shall locate steel reinforcing bars using x-ray or other approved methods. Location of holes shall be adjusted to locations that will not damage reinforcing bars; coordinate locations with the Structural Engineer.
   
   e. Where trenches are cut in the floor slab that contains structural reinforcing, reinforcing bars in the floor shall NOT be saw cut flush with the edge of the trench. See details on the structural drawings for retaining stubs of reinforcing bars (in both directions where this occurs) so they may be repaired and reinstalled as detailed by the structural engineer OR if not detailed on the structural drawings, contact the Structural Engineer before cutting begins to determine the course of action.
F. Concrete for patching trenches in the floor slab shall be in accordance with Section 033000 (do not use the concrete specification in this section for patching structural concrete floor trenches.)

2.11 PATCHING

A. Concrete or concrete block surfaces - Patch the opening with concrete, finished smooth with adjacent surface. Painting is the responsibility of the contractor doing the cutting and patching.

B. Drywall or plastered surfaces - Patch with filler compound. Painting is the responsibility of the contractor doing the cutting and patching.

C. Surfaces with finishing materials such as tiled, paneled, stone or marble surfaces - Patch the opening with cement or plaster to the underside of final finishing material. Final patching is the responsibility of the contractor doing the cutting and patching.

2.12 PIPING AND EQUIPMENT SYSTEMS MARKERS


B. Pipe banding shall consist of 1" wide single tape wrapped completely around the circumference of the pipe or insulation.

C. All color coding shall comply with ANSI A13.1 1975.

D. Pipe markers shall be manufacturer’s standard pre-printed, semi-rigid plastic, snap-on type or vinyl, pressure-sensitive type with permanent adhesive.

E. Valve tags shall be brass, plastic laminate, or plastic valve tags that are 1½" diameter or square. Indicate piping system abbreviation in ¼" high letters and sequenced valve numbers ½" high letters. Provide 5/32" hole for fastener. Provide manufacturer’s standard solid brass or plated steel chain, or plated steel S-hooks of the sizes required for proper attachment of tags to valves.

F. Equipment markers shall be manufacturer’s standard laminated plastic type. Include the following, matching terminology on schedules as closely as possible: 1) Name and plan number, 2) Equipment service. Provide approximate 2½" x 4" markers for control devices, dampers, and valves; and 4½" x 6" for equipment.

2.13 UNDERGROUND PIPING MARKERS

A. Tape: Triple-laminate, consisting of aluminum foil, polyester film, and polyethylene, 6" wide.

B. Colored background, black lettering, two lines wide, and 2" tall letters. Provide different color tape for each piping service.

C. Acceptable Manufacturer, subject to compliance with requirements: Panduit Corporation.

2.14 CEMENT GROUT
A. Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix ratio shall be 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

2.15 CONCRETE

A. Reinforcing Materials

1. Reinforcing and Joint Dowel Bars: Deformed steel bars, ASTM A 615, Grade 40, unless otherwise indicated. Furnish metal expansion caps for one end of each dowel bar. Design caps with one end closed and a minimum length of 3" to allow bar movement of not less than 1" unless otherwise indicated.


B. Concrete Materials

1. Portland Cement: ASTM C 150, Type II with tricalcium aluminate content of less than 5%.

2. Coarse aggregate shall be clean, hard, durable, uncoated limestone conforming to ASTM C-33. Use size "67" throughout with no more than one percent flint and chert by weight (i.e., when the amount of flint and chert are added together, this quantity shall be less than 1% of the coarse aggregate weight).


5. Water-Reducing Admixture: ASTM C 494, Type A.

6. Membrane-Forming Curing Compound: ASTM C 309, Type I unless other type acceptable to Engineer.

C. Proportioning and Design of Mixes

1. Prepare design mixes for concrete in accordance with applicable provisions of ASTM C 94. Use an independent testing facility for preparing and reporting proposed mix designs. The testing facility may be the same as used for field quality control testing.

2. Submit written reports to Engineer of the proposed mix at least 15 days prior to start of work. Do not begin concrete production until mixes have been reviewed by Engineer.

3. Design mixes to provide normal weight concrete with the following properties: 3500 psi 28-day compressive strength.

4. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, at no additional cost to Owner and as accepted by Engineer. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Engineer before using in work.

D. Admixtures

1. Use air-entraining admixture. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having air content within following limits: 2% to 4% air.
2. Use admixtures for water-reducing and set-control in strict compliance with manufacturer's directions.

E. Slump Limits

1. Proportion and design mixes to result in concrete slump at point of placement at not less than 1" and not more than 4".

2.16 MISCELLANEOUS MATERIALS


B. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

C. Drilled Inserts: Self-drilling expansion shields and machine bolt expansion anchors: permitted in concrete not less than four inches thick. Applied load shall not exceed one-fourth the proof test load listed by the manufacturer. Phillips Red-head, wedge anchors or equal.

D. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.

E. Bolts and nuts, except as required for piping applications, shall be carbon steel in accordance with ASTM A 307 and shall be cadmium-plated, zinc-coated steel, or Type 304 stainless steel. Each bolt shall be provided with neoprene and cadmium-plated steel washers under the heads.

PART 3 - EXECUTION

3.1 EQUIPMENT SUPPORTS

A. This Contractor shall furnish and install all bases, concrete inserts, anchor bolts, and structural steel to support the equipment, piping, etc., furnished and installed by him. Any equipment legs, guy wire, anchors, etc., or any pipe that passes through the roof shall be sealed by a method approved by the Architect.

B. Provide concrete housekeeping pads a minimum of 3-1/2" high, unless detailed otherwise, under all equipment, heaters, tanks, etc., in the equipment rooms where piping containing water is located. The horizontal distance from the equipment support to the edge of the pad shall be at least 2", but not more than 4". All exposed edges of each pad shall be ½" chamfer and all surfaces shall be smooth. The housekeeping pads shall be reinforced with wire mesh and shall be doweled to the floor.

C. Plywood backboards shall be provided for all wall mounted equipment and controls (with the exception of surface mounted cabinets). Backboards shall be constructed of 3/4" plywood grade B-C. The "B" face shall be exposed. All boards shall be painted before attachment of any surface equipment.

3.2 PIPE PROTECTION DURING CONSTRUCTION
A. Protect pipe interiors with plastic plugs or plastic sheeting during construction to protect from moisture, construction debris and dust, and other foreign materials.

3.3 BUILDING OPENINGS FOR ADMISSION OF EQUIPMENT

A. This Contractor shall ascertain from his examination of the architectural and structural drawings whether any special temporary openings or supports in the building for the admission of apparatus furnished under the Contract will be necessary.

B. The Contractor shall pay all cost of making such openings or providing such supports.

3.4 CUTTING AND PATCHING

A. All cutting that may be necessary for the installation of the work and any required patching that results therefrom shall be done by the proper trade involved and shall be included in the work of this Contractor. Columns, beams, girders or other structural members shall not be cut.

B. No openings shall be cut without written approval of the Owner's Representative.

3.5 ROOF PENETRATIONS

A. Any penetration of the roof shall be provided with an appropriate roof penetration apparatus as herein described.

B. Cutting of the metal decking for all unframed openings is the responsibility of the Contractor requiring the opening. Cutting, patching and flashing of roof shall be the responsibility of the Contractor needing the opening. Roof cutting and patching shall be coordinated with the roof installer. The original roof warranty shall be maintained.

C. When penetrations occur in new roofs, the installation of the roofing materials to the connection and the waterproofing of the roofing at the roof penetration apparatus shall be by the General Contractor.

D. At all times during construction, this Contractor shall provide temporary covers, enclosures, etc., required at roof openings to prevent injury to personnel and to prevent outdoor elements (water, wind, etc.) from entering the opening.

3.6 FLASHING

A. Provide flexible flashing and metal counter flashing where piping penetrates weather or waterproofed walls, floors, and roofs.

B. Provide acoustical lead flashing around pipes penetrating equipment rooms, installed in accordance with manufacturer's instructions for sound control where indicated on the drawings.

3.7 ACCESS

A. All control devices, equipment, specialties, valves, plumbing traps, etc., shall be so located as to provide for easy access and proper clearance for operation, maintenance, and repair.
B. Where items are located above non-accessible ceilings, in or behind walls, or in other similar concealed areas, contractor requiring access shall provide access panels.

C. Contractor shall not provide access panel to equipment above drywall ceilings without written permission of Architect/Engineer.

3.8 SLEEVES AND ESCUTCHEONS

A. This Contractor shall be responsible for locating, placing and maintaining in proper position all sleeves required for the work. In the event that failure to do so requires cutting and patching of finished work, it shall be done at this Contractor's expense.

B. Sleeves in foundation walls or footings shall be as detailed on the plans.

C. Sleeves through floors shall extend 2" above finished floors.

D. Sleeves in foundation walls or footings shall be as detailed on the plans. No sleeves, other than those shown on the drawings, shall be installed through footings or foundations without obtaining approval from the Structural Engineer.

E. Where pipes pass through existing concrete floors or walls, the hole shall be core drilled. Sleeves shall be grouted in place.

F. Where pipes pass through existing foundation walls or concrete walls below grade, the hole shall be core drilled.

G. Where pipes pass through fire walls, plaster or drywall shall be applied around the outside of the sleeve to seal between sleeve and wall.

H. The internal diameter of sleeves shall be 1" to 2" larger in diameter than the outside diameter of the pipe or pipe insulation. Insulation shall be continuous through sleeve.

I. The space between the pipes and sleeves shall be sealed as follows:

1. Exterior walls above grade: Caulking shall be applied to a minimum 3" total depth. Sealant shall then be applied on both sides of the wall opening to a minimum \( \frac{1}{2} \)" in depth, finishing flush with the wall.

2. Exterior walls below grade: The space between the pipe and the core drilled hole or sleeve shall be completely filled. Provide mechanical seal and install in accordance with manufacturer’s instructions.

3. Openings in floors or roofs: Caulking shall be applied from the upper side to a minimum depth of 3" recessed \( \frac{1}{2} \)" below the finished floor or roof. This \( \frac{1}{2} \)" recess shall then be filled with sealant to flush with finished floor or roof.

4. Interior Non-Rated Walls/Partitions:
   a. Concealed locations: Limit the size of the space between the wall and the outside of the pipe to 1" maximum. The space between the duct or pipe and the wall may be left open.
   b. Visible Locations: Openings between pipe and wall shall be covered with a chrome plated escutcheon.
5. **Interior Fire-Rated Walls/Partitions/Floors/Ceilings:**
   
a. Where pipes pass through rated assemblies (walls, floors, ceilings, etc), the pipes shall be sealed per approved methods to meet U.L. Classifications, see the details on the drawings.

J. Shop drawings shall be submitted on all fire resistant materials and methods.

3.9 **PIPING AND EQUIPMENT SYSTEMS MARKERS**

A. All piping shall be identified with color coded banding. This color banding shall be applied at the following locations:
   
1. Adjacent to each valve.
2. At each branch or riser take-off.
3. Where piping goes through floors, walls or ceilings.
4. On horizontal pipe runs at 80 foot intervals, but not less than one per room.

B. All color coding shall comply with ANSI A13.1 1975.

C. Pipe marking shall also include printed markers indicating the service and flow arrows indicating direction of flow.

D. Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibs, and shut-off valves at plumbing fixtures. List each tagged valve in valve schedule for each piping system and include valve schedule in O & M Manual.

E. Provide equipment markers on all scheduled equipment. Provide manufacturer's standard laminated plastic markers. Provide approximate 2½" x 4" markers for control devices, dampers, and control valves; and 4½" x 6" for equipment. Include the A) Name and plan number and B) Equipment service, matching terminology on schedules as closely as possible.

3.10 **LINES AND GRADES**

A. This Contractor shall set all construction stakes required for establishing the lines and grades for underground piping and equipment. He shall assume full responsibility for dimensions and elevations measured from such stakes and reset all stakes displaced or moved while the work is in progress.

B. This Contractor shall coordinate all elevations and dimensions shown on the drawings with the General Contractor and other subcontractors and report any discrepancies to the Engineer. No work shall be installed until all discrepancies have been resolved.

3.11 **EXCAVATION**

A. Excavate, as necessary, for all underground piping as indicated on drawings and/or necessary.
B. Material to be excavated shall be nonclassified and shall include all earth or other materials encountered. The contract price shall cover the removal of all such material to the depth and extent indicated on the drawings and/or herein specified.

C. Unless otherwise shown, provide separate trenches for each utility. Lay all piping in open trench except when the Engineer gives written permission for tunneling.

D. Excavation of trenches from surface to top of pipe shall be kept to a minimum but shall be of sufficient width for proper installation of the work. The excavation from bottom of trench to top of pipe shall be not more than twenty (20) inches wider than the outside diameter of the pipe to be laid therein, or where depth of backfill over pipe exceeds ten (10) feet, width of trench at top of pipe shall not exceed 4/3 of nominal diameter of pipe, plus eight inches. For larger pipe, the bottom of trench shall be shaped to conform to the lower half of pipe, and recesses four (4) inches in length shall be cut for pipe bells as required, to give uniform bearing making certain that the pipe is properly supported throughout. Provide ample excavation under and around all pipe joints to permit proper caulking, sealing, welding or thread tightening.

E. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, and fittings. Remove projecting stones and sharp objects along trench subgrade.

F. All excavations shall be properly protected by the necessary bracing and timbers to prevent any cave-ins or injury to adjacent improvements and workmen. The sides of all trenches shall be securely held by bracing or sheeting, which bracing and sheeting shall not be removed until the level of the backfill has reached the point where such removal can be safely carried out. The thickness of the sheeting and the dimensions of the cross-braces, shoes, etc., to be used by this Contractor shall be satisfactory to protect properly the sides of the trench and to prevent injurious cave-ins or erosions.

G. Grading in the area of the excavation shall be such that it shall prevent surface water from flowing into the excavated trench. Under no circumstances lay, pipe or install appurtenances in water. Keep trench free from water until pipe joint materials have hardened. The presence of ground water in the soil or the necessity of sheeting or bracing trenches shall not constitute a condition for which an increase may be made in the contract price.

H. Where underground pipes cross, the trench of the lower pipe shall be backfilled with sharp sand, well tamped, to provide bed for higher pipe. Pipes which run parallel and at different levels shall be adequately separated to provide firm bedding for the pipes. Sewer, water and gas pipes shall be run in completely separate trenches, and at least three (3) feet apart at center lines, except as approved by the Engineer. Whenever possible, water pipes shall be installed above sewer pipes and gas piping above water and sewer pipes.

3.12 BEDDING AND BACKFILLING

A. All excavations by this Contractor shall be promptly backfilled.

B. Trenches for sewers, piping, etc., shall be backfilled for a depth of at least six (6) inches over the top of pipe with sand. Bedding shall be provided in the form of six (6) inches of sand under
the pipes. It shall be carefully deposited in uniform layers not exceeding six (6) inches in depth. Each layer shall be carefully and solidly tamped with appropriate tools in such a manner as to avoid injuring or disturbing the completed work. Backfill shall be placed beneath haunches of piping and thoroughly compacted to prevent lateral displacement.

C. Backfill from 0'-6" above the top of the pipe to the surface shall be with clean on-site materials. Large rocks (over 3/4") or other materials shall be removed. Backfill shall be compacted. Compaction shall be at least 90% measured by the Proctor Test (ASTM D 698). Backfill shall be constructed in uniform layers of approximately 6 to 8 inches in loose dimension. Each layer shall be compacted.

D. Backfill from 0'-6" above the top of the pipe, sewer, conduit, etc., to the bottom side of sidewalks, parking areas, streets, floor slabs or other paved areas shall be with crushed stone or gravel with maximum size of ½".

E. Do not place fill during rainy or freezing weather or on subgrade softened by rain or thawing action. When filling is interrupted by weather, top surface of fill shall be scarified, recompacted, and tested before placing new fill. Each day's fill shall be constructed with a slope that will ensure free and rapid drainage.

F. If the soils are too wet during construction of the fill, dry by discing or other similar methods. If the soils are too dry during construction of the fill, add water in such a way as to permit uniform dispersion of the moisture through the layer to be compacted.

G. The Owner shall have the option of requiring compaction tests. If the material tested does not meet these tests, this Contractor shall bear the cost of retesting and remedial work.

END OF SECTION 220010
SECTION 22 00 20 – PLUMBING SEISMIC RESTRAINTS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide seismic restraints as indicated for each type of equipment and for piping systems. This section applies to:

1. Plumbing Systems

B. Scope of Work

1. The following items of equipment shall have flexible pipe connectors installed at the piping connection to the items:
   a. Water pumps where indicated on the plans.

2. Flexible pipe connectors are specified in the appropriate piping section of these specifications.

3. Seismic control manufacturer shall have the following responsibilities:
   a. Determine seismic restraint sizes and locations.
   b. Provide piping and equipment seismic restraints as scheduled or specified.
   c. Provide installation instructions and drawings.
   d. Provide calculations to determine restraint loads resulting from seismic forces in accordance with the Local Building Code (see below), governing codes, project seismic requirements. Seismic calculations shall be certified by a licensed engineer, experienced in the design of restraints for flexibly mounted equipment.

4. Friction from gravity loads shall not be considered resistance to seismic forces.

5. All piping shall to be restrained per the latest revision of SMACNA "Seismic Restraint Manual Guidelines for Mechanical Systems", Second Edition, 1998. At a minimum, the seismic restraint manufacturer shall provide documentation on maximum restraint spacing for various cable sizes and anchors, as well as 'worst case' reaction loads at restraint locations.

1.2 RELATED DOCUMENTS

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

B. Section 220000 - Plumbing General Conditions.

C. Section 220010 - Basic Plumbing Material and Methods.

1.3 REFERENCES

A. NFPA Standard 13

1.4 DEFINITIONS

B. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.5 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:
   1. Site Class as Defined in the IBC: C.
   2. Assigned Occupancy Category or Building Category as Defined in the IBC: IV.
      a. Component Importance Factor: See Schedule on drawings.
      c. Component Amplification Factor: See Schedule on drawings.
   3. Design Spectral Response Acceleration at Short Periods (0.2 Second): 0.430%.
   4. Design Spectral Response Acceleration at 1-Second Period: 0.167%.
   5. Seismic Design Category: D.

1.6 SUBMITTALS

A. Product Data: For the following:
   1. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
      a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by OSHPD or an agency acceptable to authorities having jurisdiction.
      b. Annotate to indicate application of each product submitted and compliance with requirements.
   2. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Delegated-Design Submittal: For seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select seismic restraints.
   2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
   3. Seismic Details:
      a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events.

c. Preapproval and Evaluation Documentation: By OSHPD or an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

C. Coordination Drawings: Show coordination of seismic bracing for piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

D. Welding certificates.

1.7 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings shall be based on independent testing. If preapproved ratings are not available, submittals shall be based on independent testing. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 SEISMIC-RESTRAINT DEVICES

A. Manufacturer and model number given are intended to establish desired type, quality and performance. Equivalent products of the following manufacturers are equally acceptable:

1. Amber/Booth Company, Inc.
2. California Dynamics Corporation.
3. Cooper B-Line, Inc.; a division of Cooper Industries.
4. Hilti, Inc.
7. Mason Industries.
8. TOLCO Incorporated; a brand of NIBCO INC.
9. Unistrut; Tyco International, Ltd.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by OSHPD or an agency acceptable to authorities having jurisdiction.
1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least 4 times the maximum seismic forces to which they will be subjected.

C. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
2. Resilient Isolation Washers and Bushings:
3. Oil- and water-resistant neoprene.
4. Maximum 1/4 inch air gap and minimum 1/4-inch thick resilient cushion.

D. Specification SB: Spring type isolators shall be free standing and laterally stable and complete with 1/4 inch neoprene acoustical friction pads or neoprene cup between the spring and the base plate. All mountings shall have leveling bolts. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflections compressed spring height and solid spring height. A steel housing shall be included to resist motion due to earthquake loads. A minimum clearance of 1/4 inch shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. The housing shall be out of contact during normal operations. Mountings used out of doors shall be hot dipped galvanized. Mounting shall be SSLFH or SLR as manufactured by Mason Industries, Inc.

E. Specification SC: Restraint Cables:

1. ASTM A 603 galvanized for interior locations and ASTM A 492 stainless for outdoor locations -steel cables with end connections made of galvanized/stainless steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement. Accessories shall be the same material as the cable. Mason Industries, Type SCB Seismic Slack Cables and Type SRC Seismic Rod Clamps.
2. Strut System: MFMA-3, shop or field-fabricated support assembly made of slotted steel channels (struts), 1-5/8 wide, in varying lengths and combinations to meet load capacities, with accessories for attachment to braced component at one end and to building structure at the other end and other matching components; and rated in tension, compression, and torsion forces. 12 gage channels unless otherwise indicated in the approved submittals. Cooper B-Line model B22 strut systems, pipe hangers, and accessories.

F. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod. Mason Industries Seismic Rod Clamps or B Line SC-228 or SC-UB Hanger Rod Stiffener.

G. Specification SG: Seismic Grommets. Resilient Isolation Washers and Bushings. One-piece, molded, oil- and water-resistant neoprene, with a flat washer face. The grommets shall be used with a steel washer between the bolt head (or nut if studs are used) and the grommet face. All anchor bolts shall be tightened until there is obvious grommet distortion and the bolt
is torqued to 80% of allowable. In no case, shall the anchor bolt torque be less than 50% of the allowable. Mason Industries, Inc. Type HG.

H. Specification SAB: Seismic Anchor Bolts.

1. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter. Mason Industries, Inc. Type SAB.

2. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Mason Industries, Inc. Type SAA.

2.2 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be galvanized.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark seismic control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive seismic control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 SEISMIC-RESTRAINT DEVICE INSTALLATION
A. Comply with requirements in Section 220010 for installation of equipment supports, and roof penetrations.

B. Equipment Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
2. Install seismic-restraint devices using methods approved by the manufacturer, the Engineer and the approved submittals for the component.
3. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
4. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

C. Piping Restraints:

2. Space lateral supports and longitudinal supports at no more than the maximum of spacing indicated on the drawings or the local building code.
3. Brace a change of direction as indicated on the drawings or the local building code.
4. Install cables so they do not bend across edges of adjacent equipment or building structure.
5. Cables shall be installed with sufficient slack to avoid short circuiting the vibration isolators. Attachment brackets at each end of the cable shall permit free cable movement in all directions up to a 45-degree misalignment. Protective thimbles shall be used at sharp connection points. Attachment bolts and anchors shall exceed the design load of the wire cable by a minimum of 50 per cent. Single sided “C” beam clamps shall not be allowed. Wire rope connectors shall be approved by the wire rope manufacturer. Vertical suspension rods shall be braced to avoid buckling due to up forces.

D. Attachment to Structure:

1. Attachments shall be as indicated on the drawings and the approved submittals. If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
2. Provide restraint attachment plates cast into housekeeping pads, concrete inserts, double sided beam clamps, etc. in accordance with the requirements of the seismic restraint vendor's calculations.
3. Capacity for concrete inserts used for support attachment shall not exceed the combination of gravity and seismic loads on the support.

E. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the Architect, Engineer, and Structural Engineer if reinforcing steel or
other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas pipes.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.

4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.

5. Set anchors to manufacturer's recommended torque, using a torque wrench.

6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 220400 Plumbing Piping Systems for piping flexible connections.

3.5 ADJUSTING

A. Adjust isolators on piping after piping system is at operating weight.

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

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.6 PLUMBING SEISMIC-RESTRAINT DEVICE SCHEDULE

A. See schedule on plans.

END OF SECTION 220020
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SECTION 22 04 00 – PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 SCOPE

A. Work under the Plumbing Contract shall include, but is not limited to, all labor, materials, equipment, tools, controls, fees, etc., required to install, test, and start-up the systems described below and/or shown on the contract drawings.

1. New Plumbing Fixtures.
2. New Plumbing Specialties.
3. New Water Heaters.
5. New Domestic Hot and Cold Water Piping.
7. New Storm Water Piping.
8. Insulation for Plumbing piping and equipment requiring insulation.
9. Any miscellaneous items required by applicable plumbing or building codes to meet improvements noted in plans or in these specifications herein.
10. Any miscellaneous or customary items required to provide acceptable performance of the fixtures and systems specified in the plans and in these specifications.
11. Installation or final connections of Owner furnished equipment as indicated on the drawings.
12. Foundation Drainage System.

B. The drawings are generally diagrammatic. Unless specifically shown, the drawings shall not be scaled for positioning of piping, fixtures, or equipment. This Contractor shall coordinate his work with the Architectural drawings and with all other trades in regard to placement of facilities. Contractor shall refer to architectural and structural plans for building construction and dimensions. Refer to architectural "Room Finish Schedules" for material and finish of walls, floors and ceiling so proper roughing-in may be provided.

C. All plumbing work shall be in accordance with the local plumbing code, the requirements of the Building Code and the Seismic requirements defined in Section 220020 and with seismic details on drawings. If any of these documents are in conflict with the local code authority, the discrepancy shall be noted by the Contractor and sent to the Engineer prior to initiating any work.

D. All permits and inspection fees required to do this work shall be paid for by Plumbing Contractor. At the completion of the work, the Contractor shall furnish a certificate of approval showing that his work has been approved and accepted by the proper inspection authorities.

E. Contractor shall be responsible for utility connections.

F. Excavate for all underground work that requires excavation. See Section 220010 of this specification for excavation and backfill requirements.

1.2 RELATED DOCUMENTS

19-2726.01 & 19-2727.01
A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.
B. Section 220000 - Plumbing General Conditions.
C. Section 220010 - Basic Plumbing Materials and Methods.
D. Section 220020 - Seismic Restraints.
E. Section 220410 - Plumbing Equipment.
F. Section 220420 - Plumbing Fixtures and Trim.
G. Section 220440 - Foundation Drainage Systems.
H. Section 220450 - Interceptors.

1.3 EQUIPMENT FURNISHED BY OTHERS

A. Where specifically indicated, some items of equipment will be furnished by the Owner or under other Divisions of these specifications.

B. Unless specifically noted otherwise for the items furnished by others, this Contractor shall receive, locate, set in place, rough-in and make final connections to all items requiring plumbing connections.

C. Unless specifically noted otherwise, for the items furnished by others, this Contractor shall furnish and install all piping, stops, traps and accessories required to make final connection.

1.4 FIXTURES FURNISHED BY OTHERS

A. Where specifically indicated on the plans, sinks, disposals, etc., will be furnished and set in place by others. This Contractor shall furnish:

1. P-trap
2. Angle Stop Valves.

B. This Contractor shall receive and install these items and make final connections.

1.5 SUBMITTALS

A. This Contractor shall submit shop drawings on all material or equipment furnished by him or his Subcontractors. Manufacturer’s technical product data and installation instructions shall be submitted on:

1. All Plumbing Fixtures
2. Floor Drain and Roof Drains
3. All Plumbing Equipment
4. Domestic Water Heaters
5. Valves and Piping Specialties
6. List of all proposed piping material and its intended use.
7. Insulation: Submit schedule showing manufacturer’s product number, k-value, thickness, and furnished accessories for each system requiring insulation.
8. Hangers and Supports: Submit schedule showing Manufacturer’s figure number, size, location, and features for each hanger and support.

1.6 QUALITY

PLUMBING SYSTEMS 220400 - 2
A. Comply with the provisions of the following:

1. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS)
   Compliance: Comply with the various MSS Standard Practices referenced.

B. References

1. ASHRAE 188-2018 Legionellosis: Risk Management for Building Water System
2. ASME B16.18 Cast Copper and Copper Alloy Solder Joint Pressure Fittings
3. ASME B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
4. ASME B16.29 Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV
5. ASTM A 74 Cast Iron Soil Pipe and Fittings
6. ASTM A 888 Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
7. ASTM B 32 Solder Metal
8. ASTM B 88 Seamless Copper Water Tube
9. ASTM B 306 Copper Drainage Tube (DWV)
10. ASTM B 813-2010 Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube.)
11. ASTM B 828 Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
12. ASTM C 564 Rubber Gaskets for Cast Iron Soil Pipe and Fittings
13. ASTM D 1784 Rigid Poly Vinyl Chloride Compounds and Chlorinated Poly Vinyl Chloride Compounds
14. ASTM D 1785 Poly Vinyl Chloride Plastic Pipe, Schedules 40, 80, and 120
15. ASTM D 2241 Poly Vinyl Chloride Pressure-Rated Pipe (SDR Series)
16. ASTM D 2321 Standard Practice for Underground PVC Pipe Installation
17. ASTM D2447 Polyethylene (PE) Plastic Pipe, Schedule 40 and 80
18. ASTM D 2464 Threaded Poly Vinyl Chloride Plastic Pipe Fittings, Schedule 80
19. ASTM D 2466 Poly Vinyl Chloride Plastic Pipe Fittings, Schedule 40
20. ASTM D 2467 Socket-Type Poly Vinyl Chloride plastic Pipe Fittings, Schedule 80
21. ASTM D 2564 Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
22. ASTM D 2657 Heat-Joining Polyolefin Pipe and Fittings
25. ASTM D 2774 Underground Installation of Thermoplastic Pressure Piping
26. ASTM D 2855 Making Solvent-Cemented Joints with Poly Vinyl Chloride Pipe and Fittings
27. ASTM D 3139 Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
28. ASTM D 4101 Propylene Plastic Injection and Extrusion Materials
30. ASTM E 814 Standard Test Method for Fire Test of Penetration Fire Stop
PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Interior Domestic Water Piping (Copper)

1. Interior Pipe 4" and Smaller:
   a. Pipe below grade shall be copper, ASTM B88, Type K, soft copper tube annealed temper. No joints shall be allowed below slab.
   b. Pipe above grade shall be copper, ASTM B88, Type "L" hard copper tube, drawn temper.

2. Fittings and Solder for Copper Tubing:
   a. All solder fittings shall be wrought copper or cast bronze solder fittings and shall bear manufacturer's trade mark. ASME B16.18 or B16.22 pressure fittings.
   b. Solder shall be 95-5 complying with ASTM B32; flux shall be ASTM B 813, water flushable type, for 4" and smaller.
   c. Copper Pressure-Seal-Joint Fittings: Fittings for NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end. Conforming to the material and sizing requirements of ASME B16.18 or ASME B16.22. O-rings for copper press fittings shall be EPDM. Copper press fittings shall be rated at 200 psi working pressure and 250 degree working temperature. All copper press fittings, couplings and specialties shall be the products of a single manufacturer. Installation tools shall be as recommended by the fittings manufacturer.

3. Piping exposed to view shall be chrome plated unless otherwise indicated on the plans.

B. Exterior Domestic Water Piping below Grade

1. Pipe Less Than 4 inch Diameter:
a. Copper Tubing:
   1) Pipe below grade shall be ASTM B 88, Type K, annealed.
   2) All fittings shall be ASME B 16.22 wrought copper or cast bronze solder
      fittings for copper tube, and shall bear manufacturer's trade mark.
   3) Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus
      alloys for general duty brazing unless otherwise indicated.

C. Sanitary Waste, and Vent Sewer Piping and Storm Water Piping

1. See application criteria in Part 3 below.
2. Bell and Spigot Cast Iron Soil Pipe and Fittings:
   b. One piece elastomeric compression type gaskets: ASTM C564.
   c. Pipe and fittings shall be encased with 8 mil thick polyethylene: AWWA C105.

3. No Hub Cast Iron Soil Pipe and Fittings:
   a. Service weight pipe and fittings: CISPI 301.
   b. Mechanical compression coupling with neoprene gasket and stainless steel band
      and accessories: CISPI 310.

4. Copper Tubing and Fittings:
   c. Joints: 95/5 type solder: ASTM B 32.

5. Poly-vinyl Chloride Pipe and Fittings:
   a. PVC schedule 40 pipe with plain ends: ASTM D-2665.

D. Valves

1. Water Valves:
   a. All valves of the same type shall be of the same manufacturer.
   b. All valves shall be lead free complying with NSF-61-G and ANSI 372.
   c. Valves shall be as indicated using the Nibco figure numbers or the approved equal
      as manufactured by Crane, Jenkins Bros., Hammond, Powell, Stockham or
      Walworth.
   d. For CW piping systems with 2" or less insulation, provide extended handles on
      stop valves with a vapor seal, adjustable memory stop and convenient valve
      packing maintenance - all without disturbing the insulation.

2. Stop valve sized through 2" shall be:
a. Nibco Fig. No. T-585-66-LF (threaded), full port 400 psi WOG non-shock at 100°F, 2-piece construction, stainless steel ball and trim and bronze body with Teflon O-ring seals and seats.

b. Nibco Fig. No. PC-585-66-LF (press system), full port 250 psi WOG non-shock at 100°F, 2-piece construction, stainless steel ball and trim and bronze body with Teflon O-ring seals and seats.

3. Check valves in sizes through 3" shall be threaded swing check valves.

4. Balance Valves

a. Valves shall be calibrated bronze balance valves with provisions for connecting a portable differential pressure meter.

b. Meter connections to have built-in check valves. An integral pointer shall register degree of valve opening. Each balance valve shall be constructed with internal seals to prevent leakage around rotating element, suitable for 100% shut-off.

c. Each balance valve shall be constructed for 150 pounds working pressure at 250°F and supplied with preformed polyurethane insulation.

2.2 Y-PATTERN STRAINERS

A. Manufacturer: Subject to compliance with requirements, provide hydronic piping system products from one of the following:

1. Armstrong Machine Works
2. Keckley
3. Illinois
4. Mueller Steam Specialty
5. Metraflex Co.

B. Pressure Rating: 125 psig minimum, unless otherwise indicated.

C. Body: Bronze for NPS 3 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 4 and larger.

D. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.

E. Screen: Stainless steel with round perforations, unless otherwise indicated.

F. Perforation Size:

1. Strainers thru NPS 2-1/2 inch: #20 mesh

G. Drain: Pipe plug.

2.3 UNIONS

A. All unions shall be streamline ground joints. Dielectric unions may be solder joint, screwed or flanged.

2.4 VACUUM BREAKERS
A. This Contractor shall furnish and install vacuum breakers in the following locations where a vacuum breaker is not an integral part of the fixture:

1. All water closet flush valves.
2. All urinal flush valves.
3. All wall hydrants and all hose bibbs.
4. Janitor’s sinks and mop basins.
5. Shelf mounted water heaters.

B. In addition to the above locations, vacuum breakers shall be installed where required by governing local authorities, on all connections to domestic water system to which hoses could be attached and all connections to the domestic water system where back siphonage could occur.

2.5 PIPE INSULATION

A. The piping insulation material is specified to establish the desired quality and performance. Equal products, complying with the requirements of these specifications, by the following manufacturers are acceptable:

1. Owens-Corning
2. Manville
3. Knauf
4. Armstrong
5. Rubbatex

B. Insulation material:

1. Type (1) - Fiberglass 25 with ASJ all service polymer jacket, seal down lap joints, vapor barrier in jacket. Thermal conductivity of 0.26 BTU/HR/SF°F/IN @ 100°F mean temperature, 0.3 @ 200°F, 0.35 @ 300°F.
2. Type (2) - (Plenum rated) foamed plastic flexible tubing insulation. Thermal conductivity of 0.28 BTU/HR/SF°F/IN @ 90°F mean temperature.

C. The installed insulating system shall comply with the requirements of the National Fire Protection Association. Insulation, including finishes and adhesives, on the exterior surfaces of pipes and equipment shall have a flame spread of 25 or less and a smoke developed rating of 50 or less as determined by an independent laboratory in accordance with ASTM E84.

D. Piping insulation material shall have a plenum rated jacket that allows for painting.

E. All insulation shall be rat, vermin, germ, fungus and rot resistant.

F. See Part 3 - Execution for items to be insulated.

2.6 HANGERS

A. Manufactured Units

1. Hangers and support components shall be factory fabricated of materials, design, and manufacturer complying with MSS SP-58 and MSS SP-69 except as modified herein.
a. Hangers: Types 5 and 12 shall not be used.
b. Hangers: Type 3 shall not be used on insulated piping.
c. C-Clamps: Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.
d. Angle Attachments: Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.
e. Hangers: Type 24 shall be used only on trapeze hanger systems or on fabricated frames.

2. Pipe supports shall be equal to B-Line model numbers hereinafter listed. Equal products by Grinnell also acceptable.

   a. Clevis Hanger Fig. B 3100
   b. Adjustable Swivel Ring Fig. B 3170
   c. Adjustable Swivel Roller Fig. B 3111
   d. Adjustable Roller Support Fig. B 3121 or Fig. B 3122
   e. Riser Clamp (Standard Duty) Fig. B 3373
   f. Riser Clamp (Heavy Duty) Fig. B 3131
   g. Offset Clamp Fig. B 3148
   h. Wall Bracket (Light Duty) Fig. B 3068
   i. Wall Bracket (Medium Duty) Fig. B 3065
   j. U-Bolts Fig. B 3188
   k. Structural Attachments:
      Beams clamps: Fig. B 3031, B 3033, B 3034, B 3050, B 3045
      Angle Iron Beam Clamp: Fig. B 3046
      Bar Joist: Fig. B 3059
      Concrete Inserts: Fig. B 3500, B 2505 thru 2508, or B 3014
      Drilled Inserts: Phillips Red-head, wedge anchors or equal.

B. Components shall have galvanized or cadmium plated coatings where installed for piping and equipment that will not have field-applied finish.

C. Pipe supports shall be compatible with the pipe being supported to prevent galvanic corrosion. All supports for copper piping shall be copper coated hangers conforming in general to the above specifications. Where copper pipes are separated from hangers by pipe insulation, hangers do not need to be copper coated.

D. Saddles and hangers for insulated piping:

   1. Type 40 shields shall:
      a. be used on all insulated pipes less than 12 inches.
      b. have rigid insulation saddle, or insulation pipe hanger consisting of rigid urethane foam insulation with vapor barrier jacket and thermal conductivity of 0.13 BTU/HR/FT²/F/IN @ 75°F. Insulation saddle length shall be 6" for pipes 6" and smaller. Thickness shall be the same as pipe insulation.
      c. distribute the loading on the bearing area of the insulation in accordance with the following minimum dimensions covering 180° of arc:
<table>
<thead>
<tr>
<th>Pipe Size (Inches)</th>
<th>Galvanized Steel Saddle Length (Inches)</th>
<th>Gauge Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>½ to 4</td>
<td>12</td>
<td>16</td>
</tr>
<tr>
<td>6</td>
<td>18</td>
<td>16</td>
</tr>
<tr>
<td>8</td>
<td>24</td>
<td>14</td>
</tr>
<tr>
<td>10 and larger</td>
<td>24</td>
<td>14</td>
</tr>
</tbody>
</table>

2.7 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

1. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:

   a. Acorn Engineering Company; Elmdor/Stoneman Div.
   b. Thaler Metal Industries Ltd.
   c. or equivalent

2. Description: Manufactured assembly made of 5.0-lb/sq. ft., 0.0782-inch thick, lead flashing collar and skirt extending at least 8 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.

PART 3 - EXECUTION

3.1 PIPING APPLICATION

A. Domestic Water Piping Above Ground

1. Piping 4" and smaller

   a. Above Ground Domestic Water Piping shall be copper.
   b. Above Ground Copper Domestic Water Piping above grade shall be soldered, or Pressure-Seal-Joint fittings as indicated below:

      1) Thru 2": Soldered or Pressure-Seal-Joint fittings.
         a) Pressure-Seal-Joint fittings not allowable in concealed locations.
            (Above drywall ceilings, in chases and in walls.)

B. Domestic Water Piping Under Building Slab or Below Ground, with-in 5' of building wall.

1. Piping 4" and smaller

   a. Copper pipe and fittings

C. Sanitary Sewer

1. Below Building Slab on Grade Install:

   a. cast iron hub and spigot
   b. PVC

2. Above Grade Install:
a. hubless cast iron
b. PVC (except not allowed in return air plenums)
c. Copper sanitary piping.

3. Beyond 5 Feet Outside Building Line:
   a. See Civil Plans.

D. Storm Water Piping
   1. Below Building Slab on Grade Install:
      a. cast iron hub and spigot
      b. PVC
   2. Above Grade Install:
      a. hubless cast iron
      b. PVC (except not allowed in return air plenums)
      c. Copper sanitary piping.
   3. Beyond 5 Feet Outside Building Line:
      a. See Civil Plans.

3.2 PLUMBING SYSTEMS INSTALLATION

A. Interior Water Piping System
   1. The Plumbing Contractor shall furnish all materials and labor to install the cold water, hot water and hot water circulating piping systems. Unless specifically stated otherwise, piping shall be extended and connected to all fixtures or equipment requiring domestic hot and cold water.
   2. All piping shall be installed level and plumb. All pipes shall be properly cleaned inside and outside.
   3. Provide strainers where indicated on the plans and details.

B. Installation of Piping
   1. All pipe shall be run parallel to or at right angles to walls, beams, or columns. Pipe shall be run as direct as possible, but no short cut diagonal methods will be allowed, avoiding unnecessary offsets and maintaining maximum headroom.
   2. Piping shall be concealed in finished rooms unless noted otherwise.
   3. Piping drawings are to be considered schematic and are not intended to indicate all changes in direction and necessary fittings to be furnished and installed by this Contractor. Pipe and fittings must be installed so that all pipe and/or insulation completely clears all nearby structures, piping and items by other contractors.
   4. Piping shall be arranged to allow for expansion and contraction. Expansion loops, expansion joints, and pipe anchors and guides shall be provided on piping mains where shown on the drawings or where required to avoid additional stresses in the piping and supports.
5. Pipes shall not be hung from other piping or from equipment of other trades. No hanger rods or piping shall pierce ductwork.


7. The entire water system shall be free of water hammer. Air chambers shall not be used in place of water hammer arresters. Install water hammer arresters where indicated on the plans and as required for all quick closing valve devices. Plumbing fixtures that require water hammer arresters shall include but not be limited to the following:
   a. Washing machines.
   b. Dishwashers.
   c. Water closets.
   d. Urinals.
   e. Drinking Fountains and electric water coolers.
   f. Ice makers.
   g. Kitchen equipment such as coffee machines, etc.

8. Valves shall be installed on each branch and at each piece of equipment, fixture or fixtures group, and all other items requiring water supply shall be separately valved to allow equipment or fixture removal without shutdown of the entire system. All valves shall be located as to be easily accessible. Install valves in horizontal piping with stem at or above the center of the pipe.

9. Use ball and butterfly valves for shut-off duty; ball, and butterfly for throttling duty. Refer to drawings for specific valve applications and arrangements. Use ball valves for isolation on pipe sizes 2” and smaller. Use butterfly valves for isolation on pipe sizes 2½” and larger.

10. Unions shall be installed:
   a. At piping connections to equipment.
   b. Connections between ferrous and non-ferrous copper pipe shall be made with dielectric unions or flanges.

11. All valves and specialties must be placed to permit easy operation and shall be made accessible to use, or provided with access panels. Special care must be taken to provide room for removing the inner parts of all specialties. Access panels must be sized properly for maintenance purposes and repairs.

12. If dope, lead or cement is used in making up joints, it shall be based on male threads only.

13. Routing of piping shall be coordinated with other trades to assure adequate space for electrical and mechanical installations above ceilings and in chases. Piping shall not be routed through electrical rooms/closets or elevator equipment rooms.

C. Installation of Hangers and Supports

1. All piping shall be supported from the building structure by means of approved hangers and supports. Piping shall be supported to maintain required grading and pitching of pipes, to prevent vibration and excessive deflections, and secure piping in place.

2. Contractor shall verify loading on hangers, hanger rods and structural attachments. Loading on the assembly shall not exceed 75% of the manufacturer’s rating for any
component of the assembly. If loading does exceed the 75%, then hanger spacing shall be reduced.

3. Hangers and supports shall be provided as required to eliminate vibration and excessive deflection, but in no case over the following centers, unless specifically indicated otherwise on the drawing. Rod sizes for individual pipe shall not be less than the following schedule: (DI= ductile iron, CI= cast iron, STL= steel, CU= copper)

<table>
<thead>
<tr>
<th>Pipe Size (Inches)</th>
<th>Maximum Hanger Spacing (Feet)</th>
<th>Minimum Rod Size (Inches)</th>
<th>Maximum Hanger Spacing (Feet)</th>
<th>Minimum Rod Size (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DI/CI/STL</td>
<td>DI/CI/STL</td>
<td>CU</td>
<td>CU</td>
</tr>
<tr>
<td>1/2</td>
<td>7</td>
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<td>5</td>
<td>3/8</td>
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<td>3/4</td>
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<tr>
<td>5</td>
<td>16</td>
<td>5/8</td>
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<tr>
<td>6</td>
<td>17</td>
<td>¾</td>
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</tbody>
</table>

a. An additional hanger shall be installed at every change in direction of piping.
b. Cast-iron and ductile iron pipe shall have minimum one hanger per section close to each joint and at branch connections.
c. Plastic pipe shall have hangers spaced in accordance with manufacturer’s recommendations.

4. When trapeze hangers are used to support two or more pipes, rods shall be used for vertical hanger members and angles, channels or Unistrut for horizontal hanger members. The material used shall be sized to support the load without excessive deflection. Spacing of trapeze hangers shall be based on the smallest pipe supported on the trapeze hanger. Rod sizes shall be based on the supported weight and load carrying capacity of attachment device.

5. Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves. Pipe hanger loads in excess of 50 pounds, suspended from steel joists, shall have the hanger loads suspended from panel points. Pipe supports for PVC piping shall be maximum 4 feet on centers. Where local codes require closer spacing than indicated on the plans or specifications, the supports shall conform to the local code requirements.

6. Vertical pipe shall be supported at each floor with riser clamps, except at slab-on-grade, and at intervals of not more than 15 feet, not more than 8 feet from end of risers, and at vent terminations.
7. Piping shall not be supported from joist bridging or a roof metal deck.
8. Pipe supports shall be structurally capable of carrying the pipe or pipes supported by them and shall be capable of vertical adjustment after installation of piping.
9. Piping at all equipment shall be supported to prevent strains or distortions in the connected equipment. Piping shall be installed and supported to allow for removal of equipment, valves and accessories with minimum dismantling and without requiring additional supports after these items are removed. Unions shall be installed at the connection to all equipment and at valves, strainers, traps, etc.
10. Domestic water pipes which are subject to rapid changes in flow rate shall be anchored to prevent excessive movement or vibration.

D. Interior Waste, Soil, Vent and Storm Piping

1. The arrangement of the system shall be as shown on the drawings, and as direct as possible avoiding all unnecessary offsets.
2. Supporting of horizontal and vertical pipe shall be as hereinbefore described under "Installation of Piping".
3. Horizontal soil and waste pipes 4" and larger shall be given a minimum slope of 1/8" per foot, and pipes 3" and smaller shall be given a pitch of 1/4" per foot. All main vertical soil and waste stacks shall be installed with provision for expansion and shall be extended full size to and above the roof line as vents, except where otherwise specifically indicated.
4. Where practical, two or more vent pipes shall be connected together and extended as one pipe through the roof. Where the Contractor makes changes of vent connections other than that indicated, he shall keep a record of the change. Vent pipes shall be run with horizontal piping pitched down to stacks without forming traps in pipes using fittings as required. Where an end of circuit vent pipe from any fixtures or line of fixtures are connected to a vent pipe serving other fixtures, the connection shall be at least 6" above the flood rim of the highest fixture above the floor on which the fixture is located.
5. All pipe shall be carefully handled and protected from damage. Damaged pipe shall not be installed.
6. All open drains shall be covered and protected during construction from all construction debris for the entire construction schedule. Open drains listed but not limited to; floor drains, floor sinks, trench drains, showers, bathtubs, lavatories, sinks, toilets, mop basins drinking fountains.
7. Bedding for underground pipes shall be as specified in Section 220010.
8. All changes in pipe size on soil, waste and drain pipes shall be made with reducing fittings or recessed reducers. All changes in direction shall be made by the appropriate use of combo wye and 1/8 bend, wye, long sweep 1/4 bends, 1/6, 1/8 or 1/16 bends, except that sanitary tees may be used on vertical stacks, and short 1/4 bends or elbows may be used in soil and waste pipes where the change in direction of flow is from the horizontal to the vertical and on the discharge from water closets.
9. Slip joints will be permitted only in trap seals or on the inlet side of the traps. Tucker or hub drainage fittings shall be used for making union connections wherever practicable in connection with dry vents.
10. Vent pipes shall be flashed. This Contractor shall furnish and install all flashing and counter-flashing. Flashing shall be 5 pound lead. Flashings in connection with cast-iron
Pipe vents will be extended up to top of vent and turned down into pipes or hubs minimum 1”. For pipes through outside walls, turn flanges back into wall, flash, metal counterflash and seal.

11. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.

12. Seal drains watertight to adjacent materials.

13. Each fixture and piece of equipment requiring connection to the drainage system, except fixtures with continuous waste, shall be equipped with a trap. Each trap shall be placed as near to the fixture as possible and no fixture shall be double-trapped. Traps installed on hub and spigot pipe shall be cast-iron. Traps installed on threaded pipe shall be recessed drainage pattern.

14. The vent stack shall be connected to the soil stack below the lowest fixture and carried up, all individual vents being connected thereto, extending through the roof.

15. Vents extending through the roof shall be a minimum of 25' from any supply fan or fresh air intake. If necessary, the vent shall be offset to meet this requirement. Check location of air intakes on equipment on roof prior to installation of vents.

16. Double wye soil, waste and storm pipe fittings are not allowed to be installed horizontally.

17. Wrap all pipe routed through concrete with polyethylene pipe guard before the pour to decouple pipe from concrete.

E. Service Entrance

1. Extend water distribution piping to connect to utility water service piping, of size and in location indicated for service entrance to building.

2. Install sleeve and mechanical sleeve seal at penetrations through foundation wall and valve pits for watertight installation.

3. Install backflow preventer at service entrance inside building; complete with strainer, pressure reducing valve, pressure gauge, test tee with valve and drain valve.

4. Minimum depth of water pipe, exterior to building, shall be below the locally established frost line, but not less than 3'–6”.

F. Installation of Underground Water Piping

1. Pipe and accessories shall be carefully lowered into the trench by means of derrick, ropes, belt slings, or other authorized equipment. Care shall be taken to avoid abrasion of the pipe coating. Except where necessary in making connections with other pipes or as authorized by the Engineer, pipe shall be laid with the bells facing in the direction of laying. The full length of each section of pipe shall rest solidly upon the pipe bed, with recesses excavated to accommodate bells, couplings, and joints. Pipe that has the grade or joint disturbed after laying shall be taken up and relaid. Pipe shall not be laid in water or when trench conditions are unsuitable for the work. Water shall be kept out of the trench until joints are complete. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that no trench water, earth, or other substance will enter the pipes or fittings. Where any part of the coating or lining is damaged, the repair shall be made by the Contractor at his expense. Pipe ends left for future connections shall be valved, plugged, or capped, and anchored, as shown.
2. Special care shall be taken to insure that the pipes are solidly and uniformly bedded and cradled. Bedding for underground pipes shall be as specified in Section 220010.
3. Water pipe connections to mains shall be left uncovered until after an acceptance inspection has been made. After approval of the connection, the trench shall be backfilled.
4. All underground water pipes shall be clamped, anchored, flushed and tested in accordance with NFPA Pamphlets 13 and 24. Provide thrust blocks.
5. PE Pipe shall be installed in accordance with ASTM D 2774. PVC pipe shall be installed in accordance with AWWA M23. Ductile-Iron Pipe shall be installed in accordance with AWWA C600.
6. 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. When made under pressure, these connections shall be installed using standard methods as approved by the Engineer.
7. Flanged pipe shall only be installed above ground or with the flanges in valve pits.
8. Polyethylene wrap shall be installed around all below grade ferrous piping, fittings and joints in conformance with AWWA Standard C105. Joints and fittings shall be cleaned, coated, and wrapped with tape after pipe tightness testing. Tape shall conform to AWWA C203 and shall be applied with a 50 percent overlap. Primer shall be as recommended by the tape manufacturer.

G. Sewer Pipe and Water Main Separation

1. Sanitary sewers parallel to water mains shall be located at least 10 feet horizontally from water mains. Distance shall be measured from edge to edge.
2. When local conditions prevent a horizontal separation of 10 feet, a sanitary sewer may be laid closer to a water main provided:
   a. That the bottom of the water main is at least 18 inches above the top of the sewer.
   b. That the joints be centered at the point of crossing and as far as possible from the water main.

H. Cleanouts and Test Tees

1. Cleanouts shall be provided at the following locations:
   a. Bottom of each exposed fixture trap not integral with the fixture.
   b. At the foot of each soil and storm water stack.
   c. At intervals not exceeding 50' for 4" sewer pipes and smaller, and not exceeding 100' for 5" sewer pipe and larger.
   d. Miscellaneous locations as shown on the plans.
   e. Where required by code.
2. Cleanouts shall be the same size as the pipe except cleanout plugs larger than 4" will not be required. Cleanouts installed in connection with cast-iron hub and spigot pipe shall consist of a long sweep 1/4 bend or one or two 1/8 bends extended to an easily accessible place, or where indicated on the drawings. An extra heavy cast-iron ferrule with screw cap plug shall be caulked into the hub of the fitting. Where cleanouts in
connection with threaded pipe are indicated and are accessible, they shall be cast-iron drainage T-pattern 90° branch fittings or Y-branch fittings with screw plugs of the same size as the pipe up to and including 4". Test tees with cleanout plugs shall be installed at the foot of all soil, waste, and drain and roof drainage stacks and on each building drain outside the building.

3. Wall Access Cover Plate: Round, flat, chrome-plated brass or stainless-steel cover plate with screw. Deep, chrome-plated bronze type may be used where a flat type does not fit.

I. Joints

1. Installation of pipe and fittings shall be made in accordance with the manufacturer’s recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees shall not be permitted. Joints shall be made up with fittings of compatible material and made for the specific purpose intended.

2. Threaded joints shall have American Standard taper pipe threads conforming to ASME B1.20.1. Only male pipe threads shall be coated with graphite or with an approved graphite compound, or with an inert filler and oil, or shall have a polytetrafluoroethylene tape applied.

3. Flanged Joints: Align flanges surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

4. Brazed joints shall be made in conformance with AWS B2.2 with flux and are acceptable for line sizes. Brazing of dissimilar metals (copper to bronze or brass) shall include the use of flux with either a copper-phosphorus, copper-phosphorus-silver or a silver brazing filler metal.
   a. CAUTION: Remove stems, seats, and packing of valves and accessible internal parts at piping specialties before brazing.
   b. Fill the pipe and fittings during brazing, with an inert gas (ie., nitrogen or carbon dioxide) to prevent formation of scale.

5. Soldered joints shall be made with flux and are only acceptable for pipes 2 inches and smaller. Soldered joints shall conform to ASME B31.5.

6. Copper Tube Extracted Tee Joints shall not be allowed.

7. Unions, flanges and mechanical couplings shall not be concealed in walls, ceilings, or partitions. Unions shall be used on pipe sizes 2-1/2 inches and smaller; flanges shall be used on pipe sizes 3 inches and larger.

8. Bell and spigot compression and hubless gasketed clamp joints for soil, waste and vent piping shall be installed per the manufacturer’s recommendations.

9. The tube or fittings for copper piping shall not be annealed when making connections.

10. PVC pipe shall have joints made with solvent cement, elastomeric gaskets, or mated flanges.

11. Joints connecting pipe of differing materials shall be made with transition fittings approved by the pipe manufacturer and in accordance with the manufacturer’s recommendation as approved by the Engineer.
J. Backup Plates

1. Where hot, cold and waste piping penetrates chase walls for connections to fixtures, this Contractor shall furnish and install backup plates. Backup plates shall span between and shall be firmly attached to the studs on either side of the fixture. Backup plate shall not be less than 3/4" plywood and shall be attached to the metal stud flange with at least three screws on each end. Holes through the backup plates for pipe penetrations shall be accurately drilled to pipe size to provide a close fit with the pipe. Piping shall be secured to the backup plate.

K. Escutcheons

1. Chrome plated escutcheons shall be provided at all locations where pipes penetrate walls in exposed locations.

L. Piping Insulation

1. Installation of the material shall comply with the manufacturer's recommendations.
2. Unions, flanges, valves and other similar fittings shall be insulated except insulation may be omitted on unions for hot water piping.
3. Prior to application of insulation, piping and equipment shall have been tested. All surfaces to be insulated shall be clean and dry. Special solvents are not required for use in cleaning, but any oil, grease, dirt or foreign material shall be wiped or scraped from the pipe or equipment surface. Insulation shall not be applied on damp or frosty surfaces.
4. All pipes with hangers, saddles, etc., shall be set in their permanent location before insulation is applied. Should it be necessary to block or shore up pipe to install insulation, or should it be necessary to displace or remove hangers, the pipe and hangers shall be restored to their original location and alignment when the insulation is complete.
5. Where insulated piping is supported by hangers clamped directly to the pipe, the insulation shall be carefully fitted around hanger clamp and sealed at openings in jacket.
6. All fittings, flanges, valves, instruments, hanger rods and clamps shall be insulated with molded or mitered insulation or built-up insulation to a thickness equal to that of the insulation of the adjoining pipe, securely adhered and wired in place. For cold services (fluid temperatures less than 75°F) paint insulation with a vapor-barrier mastic. Fittings shall be covered with preformed fitting covers. Aluminum fitting covers are equally acceptable. For cold services, wrap the end joint with pressure sensitive joint tape furnished by the insulation manufacturer.
7. At pipe hangers, pipe hanger insulation inserts the same thickness as the insulation to prevent crushing the insulation.
8. Insulate Piping as follows:

<table>
<thead>
<tr>
<th>Application</th>
<th>Insulation Type</th>
<th>Wall Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>CW &amp; NP up to 1-1/2&quot;</td>
<td>1</td>
<td>½&quot;</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>⅝&quot;</td>
</tr>
<tr>
<td>CW &amp; NP over 1-1/2&quot;</td>
<td>1</td>
<td>1&quot;</td>
</tr>
</tbody>
</table>

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PLUMBING SYSTEMS

22 04 00 - 17
HW, TW & HWR up to 2”  
1  
2  
Same as pipe size

HW, TW & HWR over 2”  
1  
2  
2”

ST (horizontal piping only) to 5”  
1  
2  
½”

6” to 24”  
1  
2  
1”

Indirect waste pipes from Kitchen equipment (ice bins, refrigerator drains, etc.) or as noted on plans.  
1  
2  
1”

Indirect waste pipes from air handling equipment.  
1  
2  
1”

Drinking fountain chilled water pipes.  
1  
2  
1-1/2”

b. The following equipment shall be insulated with 1” thick Type 1 insulation:

1) All roof drain bodies.
2) Hot water storage tanks.

3.3 PLUMBING SYSTEMS TESTING

A. It shall be the responsibility of this Contractor to test, and to place all equipment, piping, materials, etc., installed by him into proper and unattended operation.

B. Piping systems shall be tested as hereinafter described. Piping or equipment not installed by this Contractor shall not be subject to tests. Existing piping or piping which is the property of utility companies shall not be subject to tests.

C. All plumbing tests shall be made in the presence of the local Plumbing Inspector and Owner's representative unless approved otherwise by the engineer. Testing procedure shall conform to the regulations and codes of the local agency. All pipework shall be tested for leaks, cracked pipes, cracked fittings. All openings shall be capped or plugged, the pipework filled with water, and the installation proven tight before insulation and furrings are applied.

D. Piping systems shall be tested in ambient temperatures of 40°F or higher.

E. Testing of Soil, Waste and Vent Piping

1. All underground soil, waste and vent piping shall be tested with water. The water shall maintain a constant level at the highest point or at least 10' above the mean elevation.
of the piping under test for at least one (1) hour. If leaks appear, lines shall be drained, leaks repaired and test repeated. No piping shall be concealed in any manner before being tested and approved.

2. If local code is more stringent than the above test, then all soil, waste and vent piping shall be tested in accordance with local code.

F. Water System Testing

1. All water piping shall be tested with water at 100 psi or 1-1/2 times the maximum working pressure, whichever is greater. Pressure shall be maintained for a period of one hour. If leaks appear, pipes shall be drained, leaks repaired, and test repeated. No piping shall be concealed in any manner before tests are approved.

2. All domestic systems shall be chlorinated in accordance with procedures described in AWWA Standard for Disinfecting Water Mains, AWWA C601-68, and in accordance with applicable local codes. The system shall be flushed prior to chlorination as thoroughly as possible. Clean all faucets strainers and shower heads. A velocity in the system of at least 2.5 fps should be developed. Chlorine shall be added to the system at the meter at a rate sufficient to produce a chlorine concentration of 50 mg/l available chlorine and held in the system for a 24-hour retention period. After chlorination, the system shall be flushed until the chlorine residual is 1.0 ppm at all faucets and shower heads. Testing for domestic systems shall be in accordance with ASHRAE 188-2018.

END OF SECTION 220400
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1.1 DESCRIPTION OF WORK

A. Furnish all labor, services, material and related items to completely furnish and install the plumbing equipment indicated on the plans and/or specified herein.

1.2 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 220000.

B. Include dimension drawings of water heaters indicating components and connections to other equipment and piping.

C. Include heat exchanger dimensions, size of tappings, and performance data.

D. Include dimensions of tanks, tank lining methods, anchors, attachments, lifting points, tappings, and drains.

E. Indicate pump type, capacity, power requirements and affected adjacent construction.

F. Submit certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.

G. Data for inclusion in Operating and Maintenance Manual specified in Section 220000.

1.3 RELATED DOCUMENTS

A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.

B. Section 220000 - Plumbing General Conditions.

C. Section 220010 - Basic Plumbing Materials and Methods.

D. Section 220400 - Plumbing Systems.

1.4 QUALITY ASSURANCE

A. Hydraulic Institute Compliance: Design, manufacture, and install pumps in accordance with "Hydraulic Institute Standards."

B. National Electrical Code Compliance: Provide components complying with NFPA 70 "National Electrical Code."

C. UL Compliance: Provide pumps which are listed and labeled by UL, and comply with UL Standard 778 "Motor Operated Water Pumps."

D. Design Criteria: The Drawings indicate sizes, profiles, connections, and dimensional requirements, and are based on the specific manufacturer types and models indicated. Equipment having equal performance characteristics by other manufacturers may be
considered, provided deviations in dimensions and profiles and efficiencies do not change the design concept or intended performance as judged by the Engineer.

E. Motor Selection: Select pump motors which cannot overload over the full operating range of the pump.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver products to job site.
B. Store products in a dry location.
C. Retain shipping flange protective covers and protective coatings during storage.
D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
E. Comply with manufacturer's rigging instructions for handling.

1.6 NSF COMPLIANCE

A. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

PART 2 - PRODUCTS

2.1 HOT WATER CIRCULATING PUMPS

A. Centrifugal pump selections have been based on the manufacturer scheduled. Equivalent products complying with these specifications by the following manufacturers are acceptable:

1. Bell & Gossett
2. Peerless
3. Taco
4. Paco
5. Federal
6. Weinman

B. Pumps shall comply with the following:

1. In-line type with all bronze construction.
2. Suitable for continuous duty while pumping water up to 200°F.
3. Type: Vertical, single stage, close coupled, radially split casing, for 175 psig working pressure. Suitable for vertical or horizontal installation.
4. Casing: Cast iron, with suction and discharge gage ports, casing wear ring, seal flush connection, drain plug, flanged suction and discharge. Adjustable foot to support floor mounted pumps.
5. Impeller: Bronze, fully enclosed, keyed directly to motor shaft or extension.
6. Shaft: Alloy steel with bronze or stainless steel shaft sleeve in wetted area.
7. Seal: Carbon rotating against a stationary ceramic seat, carbon-ceramic type, Buna N bellows, brass and stainless steel metal parts, suitable for operating temperatures up to 225 degrees F.
8. Provide either an internal or external flush line for the mechanical seal.
9. Pump performance curves shall be included with the submittals. Pump selection shall be such that the impeller diameter does not exceed 85% of the cut water radius.
10. Volute shall be supplied with vent, drain and gauge tappings.
11. Pump speed shall not exceed 3550 rpm.
12. Coupling guard.
13. Pump capacity shall be as scheduled.

2.2 GAS WATER HEATER - CONDENSING TYPE

A. Heater shall be A.O. Smith, State, Rheem-Ruud, Lochinvar, or approved equal.

B. Glass-lined commercial, condensing, gas fired water heater. Input rating and recovery capacity as shown on drawings. Tank shall be constructed in accordance with ASME Code Section IV and stamped for 160 psi working pressure. The condensing coil flue tube shall be coated with glass lining designed for use in condensing heaters.

C. The heater shall have sealed combustion with a 120 volt/ 1 phase power burner using 3" or 4" PVC air intake and exhaust air piping suitable for 50 or 120 equivalent feet of intake piping and 50 or 120 equivalent feet of exhaust piping.

D. The water heater shall be insulated with foam or heavy density fiberglass insulation and trimmed with heavy gauge enameled steel jacket.

E. Control be a solid state temperature and ignition controller with internal diagnostics and a LED or equivalent fault display.

F. An ASME pressure and temperature relief valve shall be furnished and installed.

G. The complete water heater shall be listed by the Underwriters Laboratories for operation at outlet water temperature of 180 degrees F. Efficiency shall meet ASHRAE standard 90.1-2001.

H. The water heater shall include all standard equipment including a condensate neutralization kit, as shown on manufacturer's specification sheet, shall fit properly into the space provided for it and shall conform to the drawing requirements.

I. Provide a drain line from the flue and a condensate neutralization kit for the drain line.

2.3 EXPANSION TANK (DOMESTIC WATER)

A. Expansion tanks shall be Armstrong, Watts or approved equal.

B. Pre-pressurized steel tank with a Butyl diaphragm expansion membrane that prevents contact of water with the air. 150 psig maximum working pressure. 40 psig air precharge. Thermally fused epoxy liner. Field adjustable pre-charge. Inline mounting model.

C. See schedule on plans for size.

2.4 PRESSURE REDUCING VALVE

A. Provide Watts or approved equal by Cla-Val, Cash, or Wilkins (Zurn).

B. Water pressure regulator, ASSE type 1003, rated for initial working pressure of 150 psig minimum, size, and inlet and outlet pressures indicated. Include Y type strainer ahead of regulator.
C. 2-½ inches and smaller: Bronze body with threaded ends.

D. 3 inches and larger: Bronze or cast iron body with flanged ends. Line cast iron bodies with FDA approved epoxy coating.

E. Single seated, direct operated type.

2.5 BACKFLOW PREVENTERS

A. Reduced Pressure Backflow Preventer
   1. Watts or approved equal by Ames, Cla-Valve or Febco.
   2. Reduced pressure principle backflow preventer shall be ASSE type 1013 consisting of gate or ball valves on the inlet and outlet, an inlet strainer and a pressure differential relief valve having an ASME A 112.1.2 air gap fitting located between two positive seating check valves; suitable for 125 psi normal working pressure at temperatures up to 140°F. Size indicated on drawings.
   3. Valve bodies shall be either bronze or galvanized cast iron. Valve internals shall be constructed of bronze and stainless steel.

B. Double Check Backflow Preventer
   1. Watts or approved equal by Ames, Cla-Valve or Febco.
   2. Double check valve type backflow preventer shall be UL listed, ASSE type 1015 with gate or ball valves on inlet and outlet and strainer on inlet. Provide two positive seating check valves; suitable for 125 psi normal working pressure at temperatures up to 140°F. Provide test cocks. Size indicated on drawings.
   3. Valve bodies shall be either bronze or galvanized cast iron. Valve internals shall be constructed of bronze and stainless steel.

2.6 WATER METERS

A. Manufacturer: Subject to compliance with requirements, provide meter(s) of one of the following:
   1. Badger Meter, Inc.
   2. Hays Div., Romac Industries
   3. Hersey Products, Inc.

B. Magnetic Driver Turbine Meter
   1. Magnetic driver turbine meter type suitable for fluid with hermetically sealed register.
   2. Provide water meter with bronze outer case and bronze bottom cap. The register lid shall be made of high impact resistant plastic.
   3. The register shall be completely separated from the product to be measured and shall be available with center sweep hand, straight reading totaling in cubic feet.
   4. Water meter shall be Hersey Model MVR or equal.

C. Compound Water Meter
1. Provide Neptune Model "Tru/Flo Compound" with dual suspension rotating disc and turbine meter type.
2. Provide water meter with bronze outer case and bronze bottom cap. The register lid shall be made of high impact resistance plastic.
3. Water meter shall be provided with A.R.B. cubic feet automatic reading and billing system.

2.7 THERMOMETERS

A. Thermometers shall be equal to Weiss #A9VU35. Equivalent products complying with these specifications by the following manufacturers are acceptable:
   1. Marsh
   2. Miljoco
   3. Trerice
   4. Weiss
   5. U.S. Gauge
   6. Weksler

B. Red Reading Mercury Industrial Thermometers cast of extruded brass or aluminum closed cases, stainless steel or brass tapered bulbs with bulbs in direct contact with metal, individually calibrated tubes and engraved scales. Each 9" thermometer shall have adjustable angle and shall be installed in a matching brass separable socket with a 3/4" NPT. Stem length of socket shall be 3-1/2" except on lines where the insulation thickness exceeds 3" the stem length shall be 6" with an extension neck socket.

C. Thermal wells in liquid lines shall be brass construction of same manufacturer as thermometers with 3/4" NPT, cap and chain, and shall have Government Standard tapered walls. Socket length shall be 3-1/2" under hex, except on lines where the insulation thickness exceeds 3" the length shall be 6" including 2-1/2" extension neck.

D. All thermometers and thermal wells shall be by one manufacturer and shall be interchangeable.

E. Graduation of thermometers shall be as follows:

<table>
<thead>
<tr>
<th>RANGE(°F)</th>
<th>DIVISIONS</th>
<th>FIG. INTERVAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot Water</td>
<td>30 to 240</td>
<td>2°F</td>
</tr>
</tbody>
</table>

F. Submit shop drawings on thermometers and thermal wells.

2.8 PRESSURE GAUGES

A. Gauges shall be Trerice. Equivalent products complying with these specifications by the following manufacturers are acceptable:
   1. Marsh
   2. Miljoco
   3. Weiss
   4. U.S. Gauge
5. Weksler.

B. Gauges shall include the following:

1. 4-1/2” diameter
2. Closed type ring with clear glass
3. Bronze tube, Bourdon Type
4. Brass movement
5. 1/4” NPT bottom connections with brass tee handle cock
6. Use pressure "snubbers" at locations where gauge needle pulsation might occur

C. Graduation of pressure gauges shall be:

<table>
<thead>
<tr>
<th>RANGE</th>
<th>DIVISIONS</th>
<th>FIG. INTERVAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>City Water</td>
<td>0-150 psi</td>
<td>1.0 psi</td>
</tr>
<tr>
<td>Domestic Hot Water</td>
<td>0-100 psi</td>
<td>1.0 psi</td>
</tr>
</tbody>
</table>

D. Gauge cocks shall be brass, equal to Trerice No. 865 or 880, and shall be provided at all gauges.

PART 3 - EXECUTION

3.1 INSTALLATION OF PUMPS

A. Install pumps, where indicated, in accordance with manufacturer's published installation instructions, with recommended clearances provided for service and maintenance.

B. Install in-line pumps per manufacturer's instructions, supported from piping system, located for access to oil cups, service, and maintenance.

C. Ensure that pump units are wired properly, with rotation in correct direction, and that pump and motor grounding have been provided.

3.2 INSTALLATION OF GAS HEATERS

A. Location: Clean and dry location with a minimum of 18-inches clearance at sides and back and 48-inches in front of heater should be maintained for inspecting and servicing. Consult local codes for proper clearance. Central location is indicated in drawings.

B. Installation: Inspect the water heater and burner for possible damage that may have occurred in shipping or during storage. Check the rating plate on the hot water heater and the burner.

C. Venting: See HVAC section of specification.

D. Electrical: Wiring to the unit should conform to the National Electrical Code and/or other locally authorized code.

E. Securely anchor to floor and provide seismic restraints indicated in Section 220020.

F. Provide a PVC drain line from the boiler flue with a neutralization kit in accordance with the manufacturers installation instructions and route to a floor drain.

3.3 SERVICE ENTRANCE
A. Install shutoff valve at service entrance inside building; complete with strainer with blowdown valve, pressure gauge, and test tee with valve and pressure gauge.

B. Install pressure regulating valve with inlet and outlet shutoff valves and balance cock bypass. Install strainer with blowdown valve, pressure gauge with gauge cock on reduced pressure side.

C. Install backflow preventer at service entrance to building.

3.4 INSTALLATION OF WATER METER

A. Install water meter in accordance with utility company's installation instructions and requirements.

B. Size meter and arrange piping and specialties to comply with utility company's requirements.

C. Set meter on concrete pad as indicated. Refer to Section 220010 for concrete and reinforcing requirements.

D. Mount meter on wall brackets as indicated.

3.5 ROUGH-IN FOR WATER METER

A. Install rough-in piping and specialties for water meter installation in accordance with utility company's instructions and requirements.

3.6 EQUIPMENT CONNECTIONS

A. Piping Runouts to Fixtures: Provide hot and cold water piping runouts to fixtures of sizes indicated, but in no case smaller than required by plumbing code.

B. Mechanical Equipment Connections: Connect hot and cold water piping system to mechanical equipment as indicated. Provide shutoff valve and union for each connection; provide drain valve on drain connection. Provide valved bypass for operation of system during service. For connections 2-1/2 inch and larger, use flanges instead of unions.

3.7 INSTALLATION OF BACKFLOW PREVENTERS

A. Install backflow preventers of type and capacity indicated, at each water supply connection to mechanical equipment and systems; to other equipment and systems indicated; and in compliance with the plumbing code and authority having jurisdiction.

B. Valves shall be installed at not less than 12" above the floor with the maximum of 60" above floor.

C. Provide strainer and stop valve upstream and stop valve downstream. Provide union to allow removal of backflow preventer.

D. Provide a drain line with air gap fitting to nearest floor drain or other suitable termination point. Waste connection shall be a fixed air gap fitting with a threaded connection.

E. Backflow preventers shall be full line size.
3.8 INSTALLATION OF PRESSURE REDUCING VALVES

A. Install pressure-regulating valves with inlet and outlet shutoff valves and balance cock bypass. Install pressure gauge on valve outlet.

3.9 EXPANSION TANK INSTALLATION

A. Install expansion tanks as indicated on the drawings and in accordance with the manufacturer’s instructions. Support tank from the structure. Adjust precharge to 60 psig unless otherwise indicated on the plans.

END OF SECTION 220410
1.1 SCOPE
A. This section provides requirements for furnishing and installing water closets, mop sinks, lavatories, fixture carriers, floor drains and cleanouts.

1.2 RELATED WORK
A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.
B. For electrical connections to electric water coolers and other plumbing fixtures, not work of this section.

1.3 QUALITY ASSURANCE
A. Plumbing Fixture Standards: Comply with applicable portions of National and Local Plumbing Codes pertaining to materials and installation of plumbing fixtures or equipment.
H. NSF/ANSI 61 - Drinking Water System Components
I. NSF/ANSI 372 - Drinking Water System Components - Lead Content

1.4 SUBMITTALS:
A. Submit product data under provisions of Section 220000.
B. Describe supports, components, accessories, and sizes.
C. Data for inclusion in Operating and Maintenance Manual specified in Section 220000.

1.5 NSF COMPLIANCE:
A. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING
A. Deliver plumbing fixtures individually wrapped in factory fabricated containers.
B. Handle plumbing fixtures carefully to prevent breakage, chipping and scoring the fixture finish. Do not install damaged plumbing fixtures; replace and return damaged units to equipment manufacturer.

PART 2 - PRODUCTS
2.1 PLUMBING FIXTURES
19-2726.01
19-2727.01
A. General: Provide factory fabricated fixtures of type, style and material indicated. For each type fixture, provide fixture manufacturer's standard trim, carrier, seats, and valves as indicated by their published product information; either as designed and constructed, or as recommended by the manufacturer, and as required for a complete installation. Where more than one type is indicated, selection is Installer’s option; but, all fixtures of same type must be furnished by single manufacturer. Where type is not otherwise indicated, provide fixtures complying with governing regulations. Furnish faucets and supply stops with renewable monel seats. Lavatories and sinks shall have the correct number of holes to coordinate with the faucets and accessories indicated even if model number listed does not indicate the correct number of holes; contractor shall be responsible to properly coordinate the sink/lavatory with the faucet and accessories.

B. The named manufacturer and model number establishes a reference for quality and design. The omission of other manufacturers' names and model numbers does not limit or exclude the use of their products.

C. The following are acceptable substitute component manufacturers:

2. Faucets: Symmons, Chicago, Delta, American Std., Grohe, Moen (commercial grade)
3. Drinking Fountains Halsey-Taylor, Elkay, Haws, Oasis
4. Carriers, Drains, Cleanouts, Hose bibbs, Wall Hydrants Woodford, Josam, JR Smith, Wade, Zurn, Watts, Prier, Mifab
5. Flush Valves Sloan, Zurn
6. Sinks American Standard, Just, Elkay
7. Mop Basin Fiat, Swan, Willoughby
8. Shower Receptors Aquabath, Lasco, Oasis

D. Where battery operated fixtures are specified, contractor shall furnish and install batteries with the fixtures.

2.2 FIXTURES

A. See Drawings for Schedule

PART 3 - EXECUTION

3.1 INSTALLATION OF FIXTURES

A. Examine rough-in work of domestic water and waste piping systems to verify actual locations of piping connections prior to installing fixtures. Also examine floors and substrates, and conditions under which fixture work is to be accomplished. Correct any incorrect locations of piping, and other unsatisfactory conditions for installation of plumbing fixtures. Do not proceed with work until unsatisfactory conditions have been corrected.

B. Fasten plumbing fixtures securely to indicated supports or building structure; and ensure that fixtures are level and plumb. Secure plumbing supplies behind or within wall construction so as to be rigid, and not subject to pull or push movement.
C. Caulk between fixtures and walls with white silicone caulking.

3.2 CLEAN AND PROTECT

A. Clean plumbing fixtures of dirt and debris upon completion of installation.

B. Protect installed fixtures from damage during the remainder of the construction period.

C. Plumbing fixture shall not be used for construction preparation or cleaning, unless written approval is given by the owner.

D. Plumbing fixtures shall not be used by any contractor, unless written approval is given by the owner.

E. Cover floor drains, floor sinks, shower drains, tub drains, and any open drain pipe to keep dirt and debris out of sanitary pipe during the entire construction period.

3.3 FIELD QUALITY CONTROL

A. Upon completion of installation of plumbing fixtures and after units are water pressurized, test fixtures to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.

3.4 INSTALLATION OF FLOOR DRAINS AND FLOOR SINKS

A. General: Install floor drains and sinks in accordance with manufacturer’s written instructions and in locations indicated.

B. Install floor drains and sinks at low points of surface areas to be drained, or as indicated. Set tops of drains and sinks flush with finished floor.

C. Install drain and sink flashing collar or flange so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.

3.5 INSTALLATION OF CLEANOUTS

A. General: Install in waste piping and storm piping as indicated and as required by National Standard Plumbing Code; at each change in direction of piping greater than 45 degrees; at minimum intervals of 50 feet for piping 4 inch and smaller and 100 feet for larger piping; and at base of each stack or conductor. Install floor and wall cleanout covers for concealed piping; select type to match adjacent building finish.

B. Flashing Flanges: Install flashing flange and clamping device with each cleanout passing thru waterproof membrane.

C. Cleanout Size: Install cleanouts the same size as the soil waste lines in which the cleanouts are placed; however, no cleanout should be larger than 4 inches in diameter.

3.6 INSTALLATION OF ROOF DRAINS
A. General: Install drains in accordance with manufacturer's written instructions and in locations indicated.

B. Install drains at low points of surface areas to be drained, or as indicated.

C. Install drain flashing collar or flange so that no leakage occurs between drain and adjoining roofing. Maintain integrity of water proof membranes, where penetrated.

D. Position drains so that they are accessible and easy to maintain.

3.7 HYDRANT INSTALLATION

A. Install all hydrants in accordance with manufacturer's instructions and approved product data submittals and in accordance with details on the plans. Where manufacturer's instructions and plan details conflict, follow the more stringent requirement.

B. Install non-freeze wall hydrants in walls of sufficient stem length to prevent freezing when the hydrant is turned off. Locate wall hydrants so valve

3.8 TRAP PRIMER INSTALLATION

A. Install trap seal primer valves with valve outlet piping pitched down toward drain trap a minimum of 1/8 inch per foot and connect to floor drain body, trap, or inlet fitting. Adjust valve for proper flow.

3.9 EXPANSION TANK INSTALLATION

A. Install expansion tanks as indicated on the drawings and in accordance with the manufacturer's instructions. Support tank from the structure. Adjust precharge to 60 psig unless otherwise indicated on the plans.

END OF SECTION 220420
SECTION 22 04 40 – FOUNDATION DRAINAGE SYSTEMS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish all labor, material, services and related items necessary to completely furnish and install the footing and landscape drainage systems indicated on the plans and/or specified herein.

1.2 RELATED DOCUMENTS

A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.
B. Section 220000 - Plumbing General Conditions.
C. Section 220010 - Basic Plumbing Materials and Methods.
D. Section 220400 - Plumbing Systems.

PART 2 - PRODUCTS

2.1 DRAINAGE PIPE AND FITTINGS

A. Furnish drainage pipe complete with bends, reducers, adapters, couplings, collars, and joint materials.
B. Perforated Polyvinyl Chloride Pipe with cloth membrane shall meet ASTM D2729.
C. Perforated PVC pipe and fittings:
   1. Perforated PVC schedule 40 pipe and fittings. ASTM D-2466.

2.2 GEOTEXTILE

A. Nonwoven polyethylene or polypropylene, having a minimum weight of four ounces per square yard with an equivalent opening size of 50 to 100.

2.3 SOIL MATERIALS

A. Drainage Fill: Evenly graded mixture of natural or crushed gravel or crushed stone and natural sand.

PART 3 - EXECUTION

3.1 INSPECTION

A. General: Examine adjacent surfaces to receive foundation drainage system to verify suitability. Do not begin installation until subsurface conditions are satisfactory to accept drainage system.

3.2 INSTALLATION
A. Impervious Fill at Footings: After concrete grade beams have been cured and forms removed, place impervious fill materials and backfill adjacent to beam. Place and compact impervious fill to dimensions indicated or, if not indicated, not less than six (6) inches deep.

B. Drainage Fill Material: Place supporting layer of drainage fill material over compacted subgrade where drainage pipe is to be laid. Supporting layer shall be compacted to a depth of not less than four (4) inches, unless otherwise indicated.

C. Laying Drain Pipe: Wrap drain pipe with geotextile and solidly bed in drainage material. Provide full bearing for each pipe section throughout its length to true grades and alignment, and continuous slope in direction of flow.
   1. Lay perforated pipe with perforations down and joints tightly closed in accordance with pipe manufacturer's recommendations. Provide collars and couplings as required.

D. Testing Drain Lines: Test or check lines before backfilling to assure free flow. Remove obstructions, replace damaged components, and retest system until satisfactory.
   1. After testing drain lines, place additional drainage as shown on plans.

END OF SECTION 220440
SECTION 22 04 50 - INTERCEPTORS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provisions of General Conditions and Section 220000, PLUMBING GENERAL CONDITIONS are a part of this Section of these specifications.

B. All equipment shall be installed in compliance with manufacturer's recommendations.

1.2 SUMMARY

A. Extent of interceptors work is indicated on drawings and provisions of this section.

1.3 RELATED DOCUMENTS

A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.

B. Section 220000 - Plumbing General Conditions.

C. Section 220010 - Basic Plumbing Materials and Methods.

D. Section 220400 - Plumbing Systems.

E. Section 220440 - Foundation Drainage Systems.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The following are acceptable component manufacturers:

1. Inside interceptors: JR Smith, Wade, Zurn, Rockford, Schler

2. Outside interceptors: Champion Products, Schier, or equal

B. See schedule on drawings.

2.2 (OIL AND) GREASE INTERCEPTORS (OUTSIDE)

A. General: Provide (oil and) grease interceptors, of size and capacity as indicated.

B. Construction: Traffic rated concrete interceptor.

C. Variations: Provide the following construction feature variations:

1. 6" inlet and outlet
2. 24" dia. riser with Man-hole cover
3. 6" dia. hole on top for clean out purposes
4. mastic sealed

2.3 SAND INTERCEPTORS (OUTSIDE)

A. General: Provide sand interceptors, of size and capacity as indicated.

B. Construction: (Non-) Traffic rated concrete interceptor.

C. Variations: Provide the following construction feature variations:
1. 6" inlet and outlet
2. 24" dia. riser with Man-hole cover
3. extra clean-out hole

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which interceptors are to be installed, and substrate which will support interceptors. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF INTERCEPTORS

A. General: Install interceptors as indicated, in accordance with manufacturer's installation instructions, and in compliance with applicable codes.

B. Excavate for all underground work that requires excavation. See Section 220010 of this specification for excavation and backfill requirements.

C. Support: Anchor interceptors securely to substrate; locate so adequate clearance is provided to remove covers and sediment baskets. Set recessed units so top of cover is flush with finished floor.

D. Set interceptor so top of man-hole is flush with grade.

E. Piping: Connect inlet and outlet piping to interceptors.

3.3 PROTECTION

A. Protect interceptors during remainder of construction period, to avoid clogging with construction materials and debris, and to prevent damage from construction debris and traffic.

END OF SECTION 220450
SECTION 23 00 00 – MECHANICAL GENERAL CONDITIONS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.

B. Should a conflict arise between Section 230000 General Conditions and other Sections, the General and Supplementary Conditions of Division 1 shall take precedence.

C. The mechanical work shall comply with all provisions of the architectural, plumbing, fire protection, mechanical and electrical drawings and specifications.

D. The word "Contractor" as used in these specifications shall mean the person, firm or corporation contracting to do the described work.

E. It shall be a part of this Contractor's bid that the submission of a proposal carries with it the agreement to all items and conditions referred to in the specifications and accompanying drawings.

F. Rough-in for and connect, as shown on the drawings, facilities for equipment furnished by the Owner under a separate contract.

1.2 RULES AND REGULATIONS

A. The rules, regulations, ordinances of all applicable governing bodies in force at the time of execution of the Contract shall become a part of these specifications. These shall include the requirements of state, county, city and also the local utility companies.

B. All materials furnished and work performed in the City of Arnold (House #1) shall be in compliance with the latest applicable version of the following codes:

   International Building Code - 2015
   National Electrical Code - 2014
   International Mechanical Code - 2015
   International Plumbing Code – 2015

C. All materials furnished and work performed in Jefferson County (House #2) shall be in compliance with the latest applicable version of the following codes:

   International Building Code - 2015
   National Electrical Code - 2008
   International Mechanical Code - 2015
   International Plumbing Code - 2015
1.3  PERMITS AND FEES

   A. Cost of all fees, permits or licenses that may be required for the performance of the Contract shall be included.

1.4  PLANS AND SPECIFICATIONS

   A. The specifications and the accompanying plans (architectural, site, structural, mechanical, electrical, fire protection and plumbing) are mutually explanatory and anything described or shown on one, but not on the other, shall be considered as if shown or described on both. The intention of the plans and specifications is to provide complete functioning systems in every respect. Contractor shall furnish all material and equipment and shall perform all labor to achieve this intent, whether or not such material or equipment is indicated herein. Whenever the term "provide" is used, it shall mean "furnish and install." If a conflict exists between the drawings and the specifications or between one specification and another specification or between one drawing and another drawing, the most demanding requirement shall apply unless otherwise authorized in writing by the Engineer.

   B. Data given herein and on the drawings is as exact as could be secured. Their absolute accuracy is not guaranteed and this Contractor shall obtain and verify exact locations, measurements, levels, space requirements, etc., at the site, and shall satisfactorily adapt the work to actual conditions at the building as constructed.

   C. The drawings shall be considered schematic and are not intended to indicate all changes in direction and necessary fittings to be installed by this Contractor. Ductwork, equipment, etc., shall be installed so all items clear the structure and other building elements and maintain appropriate clearances for access, service and maintenance.

   D. Some of the details on the plans are schematic or diagrammatic. These details are not intended to show all duct, fittings, etc., required to achieve the arrangement shown on the plan view, but instead are intended to show those items, such as curbs and sealing, etc., which are not shown on the plan view. This Contractor shall appropriately adapt these details to the actual conditions of the job.

   E. Routing of piping, location of equipment, and location of other devices are shown on plans for general guidance. This Contractor shall coordinate his work with other Contractors and shall provide necessary deviations in routing as far as 10 feet from those shown to provide systems as specified or implied, without interference and pursuant to these requirements at no additional cost to the Owner, Architect or Engineer.

   F. Contractor shall not scale the drawings. Refer to architectural and structural drawings for building construction and dimensions and to room finish schedule on architectural drawings for material, finish and construction method of walls, floors and ceilings in order to insure proper rough-in and installation of contractor’s work.

   G. Changes, modifications or variations to the plans and specifications will be issued by the Engineer in writing.

1.5  DISCREPANCIES OR OMISSIONS
A. During the bidding period, should a bidder find discrepancies or omissions in any of the documents or should he be in doubt as to their meaning, he should at once notify the Engineer who will, time permitting, issue a written instruction in the form of an addendum to all bidders of record. The Engineer will not be responsible for any oral explanations or interpretations of the documents.

B. During construction, should a discrepancy or omission be found, it shall be brought to the attention of the Engineer at once for resolution.

C. No changes in contract price will be allowed for minor changes in layout or location required to avoid interferences, obstructions, etc. Contract price changes will be considered only for changes in the scope of the project requirements. All such scope changes and price revisions must be authorized in writing.

D. If discrepancies are found within the contract documents, the most demanding requirement shall take precedence unless otherwise agreed by the engineer in writing.

1.6 VISITING THE SITE

A. This Contractor, before submitting bid, shall visit the site and become thoroughly acquainted with conditions under which the work will be performed.

B. Failure to become fully acquainted with existing site conditions under which the work is to be performed will not be justification for additional compensation after the award of the contract.

1.7 HOISTING

A. Contractor shall be responsible for hoisting of all materials and equipment furnished or installed under this Section of the Specifications, in accordance with all city, state and federal rules and regulations.

1.8 SHOP DRAWINGS

A. Contractor shall submit shop drawings in compliance with the General and Special Conditions. Contractor shall field verify exact locations, measurements, and space availability at the site, etc. prior to fabricating materials and shall notify the Engineer of discrepancies in writing.

B. The Contractor shall submit copies of all required Shop Drawings and material and equipment lists.

C. Submittals shall be transmitted to SSC Engineering as paper documents, electronic documents via email attachments, or electronic documents via FTP file transfers.

1. All submittals shall include a transmittal form identifying the project name, date, contents of submittal package, and names of subcontractor, manufacturer, and supplier.

2. On an attached separate sheet clearly identify deviations from requirements in the Contract Documents, including minor variations and limitations.

3. Paper submittals shall be sent to

SSC Engineering
MECHANICAL GENERAL CONDITIONS

4. Emails regarding submittals shall be sent to “submittals@sscengineering.com”.

D. Documents transmitted in paper format shall be sent to the Architect who will forward these to SSC. If approved by the Architect prior to submitting documents, these documents may be submitted simultaneously to the Architect and SSC. SSC will return all documents to the Architect only regardless of how they were transmitted to SSC. Submit four (4) paper copies of all required Shop Drawings and material and equipment lists for the Engineer’s and Owner’s sole use. The Contractor shall submit additional paper copies that will be required for his own use and the Operation and Maintenance Manuals. The additional copies will be reviewed by the Engineer and returned to the Contractor marked accordingly.

E. Documents transmitted as email attachments shall be sent simultaneously to the Architect and SSC. SSC will return one (1) electronic copy of these documents to the Architect only.

F. Documents transmitted via FTP file transfers shall be retrieved from the FTP site after SSC has received an email notification that these documents have been posted to the site. SSC will return one (1) electronic copy of these documents to the Architect only unless another procedure is agreed to in writing by the Architect and the Engineer.

G. Contractor shall review and correct all shop drawings before they are submitted. Shop drawings shall bear the signed and dated approval stamp of this Contractor.

H. Shop drawings shall include the plan mark used on the plans.

I. Valve and fitting shop drawings shall indicate the intended service.

J. Equipment shop drawings shall give capacities at conditions specified and shall include manufacturer's catalog numbers and cuts. Shop drawings shall be clearly marked; shall indicate all accessories, items, conditions, etc., which are being furnished; and shall indicate that all conditions of the plans and specifications are being met. Wiring diagrams shall be submitted.

K. Submittals which do not provide the required information will be returned unchecked.

L. Contractor shall be responsible for deviations, errors and omissions, quantities, and coordination dimensions in submittals, and this responsibility shall not be relieved by Engineers' review of submittals.

M. This Contractor shall coordinate each submittal with the contract documents, work of other contractors, and job site conditions.

N. The Contractor shall not be relieved of responsibility for deviations from requirements of the Contract Documents by the Engineer's approval of Shop Drawings, Product Data, Samples or similar submittals unless the Contractor has specifically informed the Engineer in writing of such deviation at the time of submittal and (1) the Engineer has given written approval to the specific deviation as a minor change in the Work, or (2) a Change Order or Construction Change Directive has been issued authorizing the deviation. The Contractor shall not be
relieved of responsibility for errors or omissions in Shop Drawings, Product Data, Samples or similar submittals by the Engineer’s approval thereof.

1.9 OPERATING AND MAINTENANCE INSTRUCTIONS AND MANUALS

A. Upon completion of the job, the installing contractors and major suppliers shall instruct the Owner’s representatives in the proper operation and maintenance of the systems installed. The installing Contractors shall submit documentation indicating the date of instruction; names and organization of persons providing and receiving the instructions; systems the instructions covered; and materials received.

B. Contractor shall also submit four (4) complete hard copy sets and one (1) electronic copy of properly bound operating manuals to the Engineer for review. These manuals shall include the following:

1. Include a Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
2. Complete set of shop drawings.
3. Copies of all submittals.
4. Parts lists, wiring diagrams, piping diagrams, etc.
5. Manufacturers' operating and maintenance instructions.
6. As-built drawings.
7. Written operating and maintenance instructions for the system. This is a written version of Paragraph "1" above.
9. Parts lists for each piece of equipment and name of local supplier.

1.10 AS-BUILT RECORD DRAWINGS

A. During construction, a separate set of plans at the jobsite shall be maintained by the Contractor to keep a record of all changes of locations. See additional requirements in General Conditions and Supplementary Conditions.

B. Locations of piping, ductwork and other concealed facilities are to be shown by the Contractor if and when they differ from the drawings. Underground piping shall be dimensioned on those drawings.

C. "As built" drawings are to be submitted to Architect/Engineer for review prior to the time of request for final payment. Submit as-built record drawings in accordance with the General Conditions.

D. For drawings that SSC has furnished to the contractor in CAD format, contractor shall prepare “As Built” drawings in CAD format. "As built" drawings in CAD format are to be submitted to Architect/Engineer, in addition to marked up paper documents for review prior to the time of request for final payment. Submit as-built record drawings in accordance with the General Conditions.

1.11 GUARANTEE AND WARRANTY
A. This Contractor shall guarantee and warrant all equipment, materials, workmanship, installation, etc., for a period of one year in accordance with the General Conditions. This one-year warranty shall commence on satisfactory completion of final punch list items. Satisfactory completion of the final punch list will be determined by the Engineer. If the Owner accepts a portion(s) of the project earlier than the rest, such as partial beneficial occupancy, that portion’s warranty shall begin on the date it is accepted as substantially complete. A project may have multiple warranty periods in these certain cases and will be fully coordinated between the Owner, the Architect and the Engineer.

B. During the guarantee period, this Contractor shall make all required repairs and replacements, and shall provide all necessary service, labor, tools, materials, parts, etc., required at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 MATERIAL SUBSTITUTION

A. Equipment selection has been based on one manufacturer to establish the desired type, style, quality, performance, etc. When other manufacturers are listed as equally acceptable, the product of those manufacturers will be accepted if their product complies with these specifications and drawings. The listing of a manufacturer does not relieve that manufacturer from complying with the specifications and drawings.

1. For manufacturers other than those listed, the Contractor shall prepare and submit to the Architect/Engineer for review, a proposal to provide a substitution. Proposal shall be submitted minimum ten (10) working days before the bid date and written approval shall be received from the Architect/Engineer before including the substitution in the bid. Substantiate that the substitution complies with the intent of the Project Documents and include sufficient information of the changes required so that a judgment may be rendered.

2. Proposal shall include a drawing originated by the Contractor. The design shall show the intended installation to the same level of detail as that of the original design in addition to catalog cut, assembly manual, or other generic documents printed by the manufacturer or their representative.

3. Prior to submitting the proposal, the Contractor shall notify all other contractors whose work is affected and request details and pricing of their respective changes. This information along with the Contractor’s details shall be transmitted to the Architect/Engineer for approval.

4. If the proposal is accepted, the Contractor shall compensate other trades which are affected by said proposal.

B. All equipment and materials are subject to the review and approval of the Engineer and Architect.

C. All differences in cost involved in using an equally acceptable manufacturer shall be included in this Contractor’s bid. This contractor shall be responsible for any and all engineering and
installation variations due to the substituted equipment. These include structural, electrical, architectural, plumbing, mechanical, fire protection, etc. changes.

D. Deviations from these specifications are not solicited and are not encouraged. If a deviation between the specifications or drawings and items bid does exist, then that deviation must be clearly itemized and explained on the bid form.

E. Solvent based adhesives or sealants shall not be substituted for water based adhesives or sealants.

PART 3 - EXECUTION

3.1 GENERAL

A. Contractor shall provide all material, equipment, labor, services, and supplies, required to execute all work shown on the mechanical drawings; described in these specifications; or made necessary by the work shown on the drawings and/or described in these specifications.

B. Contractor shall schedule all work and furnish the required materials in such a manner that the work may progress from start to finish in an expeditious and efficient manner without undue interruption. This Contractor shall also schedule his work to coordinate with the construction staging for this project.

C. Contractor shall hire the proper trades to accomplish the work described on the drawings or in the specifications.

3.2 COORDINATION OF TRADES

A. Prior to the fabrication or installation of any materials, Contractor shall review the drawings indicating work to be performed by each trade. If conflicts occur, they shall be brought to the attention of the Engineer for resolution.

B. If Contractor installs the work without coordinating with the other trades, then, if requested by the Owner, Architect, or Engineer, Contractor shall remove and rework some installed work to resolve a conflict, and such change shall be done at no change in contract price.

C. The Contractor supplying the equipment shall furnish all motors and components which are part of the equipment.

D. Control wiring is defined as that wiring which conducts electrical energy at a voltage of less than 100 volts. Interlock wiring is defined as that wiring which performs a control function, but at a voltage of 100 volts or greater. All other wiring shall be considered power wiring.

E. The Electrical Contractor shall provide power wiring to, and including connection to the equipment. Unless specifically noted otherwise, all interlock wiring shall be provided by the Electrical Contractor. Unless noted otherwise, the control wiring shall be provided by the Contractor furnishing the controlled equipment.

F. Unless noted otherwise, the Electrical Contractor shall provide all starters, disconnects, switches, push-button stations, etc., except those which are furnished with the equipment as a part of a factory-assembled package. Heater elements for overload relays on magnetic motor
starters (except the starters factory pre-wired with equipment) shall be sized, furnished and installed by the Electrical Contractor. Magnetic motor starters for mechanical equipment (except starters factory pre-wired with equipment such as chillers and packaged air conditioners) shall be provided by the Electrical Contractor. Magnetic motor starters will be provided with:

1. Auxiliary contacts as required by the interlocks defined on the drawings or in the specifications.
2. Control Power Transformer - 120 volt secondary, minimum 40 Volt Amps.

G. Each Contractor furnishing motor-operated equipment shall furnish a list of motor characteristics to the Electrical Contractor so that properly sized heater elements may be provided. The list shall include equipment identification by name and by number, the full load current, locked rotor current, voltage rating, and suggested service factor to compensate for operating duty cycle and ambient temperatures.

H. Unless specifically noted otherwise, pilot controllers (aquastats, flow switches, pressure switches, etc.) shall be furnished and mounted by the Contractor furnishing the controlled equipment.

I. Unless specifically noted otherwise, thermal wells for temperature control system sensors shall be provided by the Temperature Control Contractor and installed by the Mechanical Contractor.

J. Unless specifically noted otherwise, control valves and control dampers shall be furnished by the Temperature Control Contractor and installed by the Mechanical Contractor.

K. Electrical Work For Mechanical Equipment: Electrical Contractor shall wire all mechanical equipment furnished by various contractors in accordance with the following general provisions:

1. Power wiring from panel to motor controllers, relays, etc., and from controller to motor terminals per equipment manufacturer's wiring diagram.
2. Receive, unload, set and align all separately shipped motors. Adjust and align drive and adjust belt tension.
3. Field lubricate all motors prior to initial operation of same.
4. Install individual motor starters specifically called for to be furnished by other Contractors when not a factory pre-wired component.

L. HVAC Contractor shall provide the following:

1. All motors, disconnect switches or control devices specifically called for.
2. Automatic control and interlock wiring diagrams as called for in the specifications.
3. Complete and accurate wiring diagrams to Electrical Contractor for all equipment requiring electrical power wiring including motor terminal connection diagrams.
4. Adjustable motor bases and all bolts and nuts required for installation of base and motor.
5. Supervision of Electrical Contractor in lubrication of motors to eliminate possibility of motor starting or operating without proper lubrication and control systems.
3.3 PROTECTION OF EQUIPMENT AND WORK

A. This Contractor shall, at all times, protect and preserve all materials, supplies, equipment, piping, etc., from damage due to weather, corrosion, dirt, vandalism, theft, etc., and shall further provide all enclosures or special protection as indicated by circumstances.

B. Should any of the materials, equipment, etc., be damaged as a result of his negligence, then this Contractor shall be held responsible for all such damage and costs incurred for repair or replacement.

3.4 CONSTRUCTION STAGING

A. See schedule in Division 0 and Division 1. This Contractor shall cooperate with and coordinate to plan and schedule the work to satisfy the schedule.

3.5 MAINTENANCE OF WORK AREAS

A. During the project, this Contractor shall maintain his work area in an organized manner, shall not allow debris to accumulate, and shall store equipment, tools and supplies in a manner which shall not cause interference with the activities of others engaged on the project.

B. Open ends of pipe, ductwork, equipment, and specialties shall be kept properly closed during construction and installation so as to avoid contamination.

3.6 CLEANING AND CLEANUP

A. Upon completion of this work, the Contractor shall clean all pipe, ductwork, fixtures, and equipment. Contractor shall leave all work in a finished, clean, and satisfactory working condition.

B. Each contractor shall be responsible for his own cleanup to a central location designated by the Owner. Contractor shall periodically remove all rubbish, crating, unused material, outfall, and any other debris created by him during the course of the work.

END OF SECTION 230000
SECTION 23 00 10 – BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section covers basic mechanical materials and methods for the systems listed below and applies to work of those sections. Provide Basic Mechanical Material and Methods as indicated and required.

1. Mechanical

1.2 RELATED DOCUMENTS:

A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.

B. Section 230000 - Mechanical General Conditions.

PART 2 - PRODUCTS

2.1 PRODUCT CRITERIA

A. Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product for at least 5 years.

B. Products shall be supported by a service organization which maintains an inventory of repair parts and is located within 100 miles of the jobsite.

2.2 MATERIALS AND STANDARDS

A. All equipment and materials furnished by this Contractor shall be new, and where two or more items of the same kind are required, they shall be the product of the same manufacturer.

B. All materials, equipment, operations, procedures and installation of all materials and equipment shall conform to:

- ADA Americas with Disabilities Act
- ASME American Society of Mechanical Engineers
- UL Underwriters’ Laboratories, Inc.
- NFPA Applicable sections of the National Fire Protection Association
- NEMA National Electrical Manufacturers Association
- OSHA Occupational Safety and Health Administration
- NEC National Electrical Code
- AMCA Air Moving and Conditioning Association
- ASHRAE American Society of Heating, Refrigeration and Air Conditioning Engineers
- ARI Air Conditioning and Refrigeration Institute
- ANSI American National Standards Institute, Inc.
- ASTM American Society for Testing Materials
- SMACNA Sheet Metal and Air Conditioning Contractors’ National Association
- IPCEA Insulated Power Cable Engineers Association
HEW  U.S. Department of Health, Education and Welfare  
PDI  Plumbing and Drainage Institute  
NSF  National Sanitation Foundation  
IEEE  Institute of Electrical and Electronic Engineers  
AWWA  American Water Works Association

C. All materials used shall be applied in compliance with the manufacturer's recommendations. If a discrepancy occurs between the application of materials as called for on the drawings or in the specifications and the manufacturer's recommendations, this discrepancy shall be called to the Engineer's attention before materials are purchased or applied.

D. Abbreviations

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2.3 PREFABRICATED SEISMIC RATED ROOF CURBS
A. Prefabricated curbs shall be made of heavy-gage galvanized steel with mitered and welded corners (steel gauge as required to meet local codes) and have angle reinforcement, supply and return duct channels, insulated pans, 1-1/2-inch-thick rigid fiberglass insulation adhered to inside walls, built-in cant and mounting flange for flat roof decks and 2-inch wood nailer. Curbs shall be Thycurb TC-3 for roof decks that are not surface insulated, and Thycurb TC-1 for decks that are surface insulated.
B. Provide 14 inches high, where no other height is shown.
C. Seismic rated curbs shall be designed/constructed to meet the required local seismic codes, designed to mate perfectly with the rooftop manufacturer's equipment.
D. Seismic calculations shall be provided with shop drawings.
E. Equivalent products, complying with these specifications, by the following manufacturers are acceptable:
   1. Pate
   2. Thybar
   3. Roof Products & Systems

2.4 PREFABRICATED PIPE CURB ASSEMBLIES
A. Prefabricated pipe curb assemblies shall be heavy-gage, galvanized steel curb with mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; built-in cant and mounting flange for flat roof decks; and 2-inch wood nailer. Provide 14 inches high, where no other height is shown. Unit shall be furnished with an acrylic clad thermoplastic cover, fastening screws, and graduated step boots with stainless steel clamps. Units shall be Thycurb model TCC.
B. Equal products, complying with these specifications by the following manufacturers are acceptable:
   1. Pate
   2. Roof Products & Systems
   3. Thycurb
   4. Approved Equal

2.5 FLASHING:
A. Metal Flashing: 26 gage galvanized steel.
B. Lead Flashing: 5 lb/sq ft sheet lead for waterproofing; one lb/sq ft sheet lead for soundproofing.
C. Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing.
D. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.6 MISCELLANEOUS MATERIALS
19-2726.01 & 19-2727.01
A. Steel Plates, Shapes, and Bars: ASTM A 36. Interior applications shall be galvanized steel or black steel. Exterior applications shall be galvanized steel.

B. Strut systems shall be painted steel equal to B-Line Systems or Unistrut. Where used in exterior applications, the materials shall be galvanized steel.

2.7 SLEEVES

A. Exterior And Foundation Walls:

1. All piping through exterior walls, new concrete walls, or new foundation walls shall pass through sleeves which shall be large enough to allow for caulking and sealant materials. No sleeves shall be permitted through concrete structural members unless indicated on the structural drawings or approved by the Structural Engineer. Sleeves shall be cut smooth and flush with each side of the wall.

   a. Sleeves above grade shall be Schedule 40 PVC pipe.
   b. Sleeves below grade shall be cast iron or Schedule 40 PVC pipe.

2. All duct openings through exterior walls shall be sleeved with 20 gage galvanized steel sheet metal with flanges turned away from the opening on both sides unless otherwise indicated on the drawings. Space between sleeve and duct shall be packed with fiberglass and sealed on both sides.

B. Interior Walls And Partitions:

1. Fire Rated Walls:

   a. Piping through fire rated interior walls and partitions shall pass through either Schedule 40 black steel or 20 gauge galvanized steel sheet metal sleeves (18 gage sheet metal sleeves shall be installed if required by the U.L. classification). Schedule 40 steel pipe sleeves shall be used when required for structural purposes. Sleeves are not required for automatic control tubing.
   b. Duct through fire rated interior walls and partitions shall be connected to sleeves with fire dampers. See section 230900, Air Distribution.

2. Non Rated Partitions:

   a. Concealed Locations: Sleeves are not required for piping or ducts unless otherwise indicated on the drawings.
   b. Visible Locations except in boiler, utility, or equipment rooms:

      1) Openings between duct and wall shall be covered with 24 gage galvanized steel sheet metal angles to form an escutcheon over the opening.
      2) Openings between pipes and wall shall be covered with escutcheons. Where required, special deep-type escutcheons shall be used. Escutcheons shall be chrome plated, one-piece or split-pattern, and secured in place.

3. Mechanical Room Walls and other locations indicated on the drawings: Duct openings shall be sleeved with 22 gauge galvanized steel sheet metal with flanges turned away
from the opening on both sides. Space between sleeve and duct shall be packed with fiberglass and sealed on both sides.

2.8 BACKING & SEALANTS:

A. Backing and sealant for piping and ducts passing through floors, plaster ceilings, partition, and walls shall be as follows:

1. Backing Material:
   a. A pure ceramic fiber made of alumina-silica; "Cerafiber- FS" by Manville or equal.
   b. Insulation: Glass fiber type, non-combustible.

2. Sealant: Gun Grade. An 1-part neutral- and basic-curing Silicone sealant, “790” by Dow Corning Corporation; “Spectrem 1 (Basic)” by Tremco, or SilPruf LM SCS2700 by GE Silicones.

3. Mechanical Seal: Link-Seal or approved equal. A modular mechanical sealing assembly consisting of interlocking rubber links shaped to fill the annular space between the pipe and sleeve; corrosion-protected carbon steel bolts, nuts, and pressure plates. After the assembly is positioned in the sleeve, tightening the bolts shall cause the rubber links to provide a watertight seal between the pipe and the sleeve. Seal assembly shall be sized as recommended by the manufacturer. Provide sleeves of proper diameters.

4. Fire Retardant Sealants: Products used shall be U.L. Classified and approved for the application. Products shall produce non-toxic fumes and shall be PCB and asbestos free. Subject to compliance with requirements, provide fire retardant sealant products from one of the following: 1) “SpecSeal” by Specified Technologies Inc. 2) 3M, 3) Chase Technology Corporation, 4) Link-Seal, 5) Pyro-Pac by Thunderline Corporation, 6) “Fyre Seal” by Tremco, 7) Pensil 100 by General Electric, 8) Pensil by STI, or 9) "Flameseal" by G. S. Nelson Electric.
   a. Acrylic 1-part silicone rubber, gun applied, fire retardant elastic sealant, "Fyre Seal" by Tremco.
   b. Silicon foam sealant, CTC PR-855 by Chase Technology Corporation.
   d. Intumescent Sealant (SpecSeal SSS100) shall be one-part, two stage intumescent latex compound, expands a minimum of 8 times when exposed to 230°F to >1000°F, thixotropic. Sealant shall be capable of caulking or troweling on to vertical surfaces or overhead. Sealant shall be water-based, sandable, paintable, red in color, and safe for contact with plastics.
   e. Flexible Sealant (SpecSeal LC150) shall be one-part, latex-based compound, flexible and non-shrinking when dry, thixotropic. Sealant shall be capable of caulking or troweling on to vertical surfaces or overhead. Sealant shall be water-based, sandable, paintable, blue in color, and safe for contact with plastics.
f. Flexible Silicone Sealant (SpecSeal Pensil 300) shall be one-part, neutral curing silicone, completely water resistant, contain no solvents nor inorganic fibers, allow movement of +/-50%. Sealant shall be auto-bonding, ozone and UV resistant, chemical resistant and capable of caulking or troweling on to vertical surfaces or overhead.

g. Intumescent Putty (SpecSeal Firestop Putty) shall be one-part, two stage intumescent, non-hardening compound, expands a minimum of 5 times when exposed to 230°F to >1000°F. Putty shall be soft and pliable with aggressive adhesion, contain no water-soluble intumescent ingredients, water-based, sandable, paintable, red in color, and safe for contact with plastics.

h. Putty Pads (SpecSeal Firestop Putty Pads) shall be one-part, two stage intumescent, non-hardening compound, expands a minimum of 5 times when exposed to 230°F to >1000°F. Putty shall be soft and pliable with aggressive adhesion, contain no water-soluble intumescent ingredients, water-based, sandable, paintable, red in color, and safe for contact with plastics.

i. Pillows (SpecSeal Firestop Pillows) shall be an intumescent pillow heat sealed in a fire-retardant poly bag with a monolithic core encapsulated by flexible intumescent coating and shall expand when exposed to 230°F to >1000°F.

j. Mortar (SpecSeal Firestop Mortar) shall be light weight, fast drying, portland cement based, wet mortar density shall be ≤52 lb./cu.ft., dry mortar density shall be ≤45 lb./cu.ft., approved for combustible and noncombustible penetrants, have chemical adhesion, and be red in color.

k. Silicone Foam (SpecSeal Pensil Silicone Foam) shall be two-part, silicone, room temperature curing foam, completely water resistant, contain no solvents nor inorganic fibers, allow movement of expansion, contraction and vibration.

l. Intumescent Collars (SpecSeal Firestop Collar) shall be factory assembled collar utilizing a molded two stage flexible intumescent insert, insert shall expand a minimum of 15 times when exposed to 230°F to >1000°F, suitable for CPVC, ABS, ABS Foam Core, and FRPP pipes.

m. Intumescent Wrap Strips

1) (SpecSeal Firestop Red Wrap Strip) shall be highly flexible, two-stage intumescent material and shall expand a minimum of 15 times when exposed to 230°F to >1000°F.

2) (SpecSeal Series Blu Wrap Strip) shall be highly flexible, two-stage intumescent material and shall expand a minimum of 30 times when exposed to 230°F to >1000°F.

n. Intumescent coatings (SpecSeal Cable Coating) shall be water based, intumescent coating, expand a minimum of 5 times its dry applied thickness, flexible, water and weather-resistant film, contain no solvents or inorganic fibers. Coating shall be thixotropic and be capable of being applied by brush application or by airless spray.
o. Urethane Joint Sealants
   1) Subject to compliance with requirements, provide one of the following:
      a) Pacific Polymers International, Inc.; Elasto-Thane 230 LM Type II.
      b) Polymeric Systems, Inc.; PSI-901.
      c) Approved equal.

5. Single-Component, Nonsag, Urethane Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT.

2.9 LINTELS:
   A. Unless otherwise indicated on plans, all lintels required for the support of building construction above pipes, boxes, panels, ducts, etc., shall be furnished and installed by the Contractor requiring the opening.
   B. Lintels furnished shall be ASTM A 36 structural steel angles, channels, or tees of proper size and sections for the load being supported.

2.10 CUTTING
   A. Each Contractor shall be responsible for any cutting required for openings for conduits, pipes, ducts, etc., if sleeves or openings are not otherwise provided. Under no circumstances shall any structural members, load bearing walls, or footings be cut without first obtaining written permission from the Structural Engineer. All cutting and patching shall be done at the expense of the contractor requiring the cutting.
   B. Cutting shall be limited to the size necessary for working conditions. When cutting surfaces are difficult or costly to replace, such as glazed tile, wood paneling, etc., each contractor shall obtain the Owner’s approval in advance of the cutting and patching.

2.11 PATCHING:
   A. Concrete or concrete block surfaces - Patch the opening with concrete, finished smooth with adjacent surface. Painting is the responsibility of the contractor doing the cutting and patching.
   B. Drywall or plastered surfaces - Patch with filler compound. Painting is the responsibility of the contractor doing the cutting and patching.
   C. Surfaces with finishing materials such as tiled, paneled, stone or marble surfaces - Patch the opening with cement or plaster to the underside of final finishing material. Final patching is the responsibility of the contractor doing the cutting and patching.

2.12 PIPING and EQUIPMENT SYSTEMS MARKERS
   A. Markers shall be by Allen Systems, Inc., W.H. Brady Co.- Signmark Div., Industrial Safety Supply Co., Inc. or equal.
   B. Pipe banding shall consist of 1\" wide single tape wrapped completely around the circumference of the pipe or insulation.
C. All color coding shall comply with ANSI A13.1 1975.

D. Pipe markers shall be manufacturer's standard pre-printed, semi-rigid plastic, snap-on type or vinyl, pressure-sensitive type with permanent adhesive.

E. Valve tags shall be brass, plastic laminate, or plastic valve tags that are 1½" diameter or square. Indicate piping system abbreviation in ¼" high letters and sequenced valve numbers with ½" high letters. Provide manufacturer's standard solid brass or plated steel chain, or plated steel S-hooks of the sizes required for attachment of tags to valves.

F. Equipment markers shall be manufacturer's standard laminated plastic type. Include the following, matching terminology on schedules as closely as possible: 1) Name, 2) Tag Number, and 3) Equipment Service. Provide approximate 2½" x 4" markers for control devices, dampers, and valves; and 4½" x 6" for equipment.

2.13 CEMENT GROUT

A. Grout: ASTM C 1107, Grade B, factory-mixed and-packaged, non-shrink and nonmetallic, dry, hydraulic-cement grout.
   1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
   3. Design Mix: 5000-psi, 28-day compressive strength.

2.14 CONCRETE

A. Reinforcing Materials
   1. Reinforcing and Joint Dowel Bars: Deformed steel bars, ASTM A 615, Grade 40, unless otherwise indicated. Furnish metal expansion caps for one end of each dowel bar. Design caps with one end closed and a minimum length of 3" to allow bar movement of not less than 1" unless otherwise indicated.

B. Concrete Materials
   1. Portland Cement: ASTM C 150, Type II with tricalcium aluminate content of less than 5%.
   2. Coarse aggregate shall be clean, hard, durable, uncoated limestone conforming to ASTM C-33. Use size "67" throughout with no more than one percent flint and chert by weight (i.e., when the amount of flint and chert are added together, this quantity shall be less than 1% of the coarse aggregate weight).
   5. Water-Reducing Admixture: ASTM C 494, Type A.
   6. Membrane-Forming Curing Compound: ASTM C 309, Type I unless other type acceptable to Engineer.

C. Proportioning and Design of Mixes
1. Prepare design mixes for concrete in accordance with applicable provisions of ASTM C 94. Use an independent testing facility for preparing and reporting proposed mix designs. The testing facility may be the same as used for field quality control testing.

2. Submit written reports to Engineer of the proposed mix at least 15 days prior to start of work. Do not begin concrete production until mixes have been reviewed by Engineer.

3. Design mixes to provide normal weight concrete with the following properties: 3500 psi 28-day compressive strength.

4. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, at no additional cost to Owner and as accepted by Engineer. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Engineer before using in work.

D. Admixtures

1. Use air-entraining admixture. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having air content within following limits: 2% to 4% air.

2. Use admixtures for water-reducing and set-control in strict compliance with manufacturer's directions.

E. Slump Limits

1. Proportion and design mixes to result in concrete slump at point of placement at not less than 1" and not more than 4".

2.15 MISCELLANEOUS MATERIALS


B. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

C. Drilled Inserts: Self-drilling expansion shields and machine bolt expansion anchors: permitted in concrete not less than four inches thick. Applied load shall not exceed one-fourth the proof test load listed by the manufacturer. Phillips Red-head, wedge anchors or equal.

D. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.

E. Bolts and nuts, except as required for piping applications, shall be carbon steel in accordance with ASTM A 307 and shall be cadmium-plated, zinc-coated steel, or Type 304 stainless steel. Each bolt shall be provided with neoprene and cadmium-plated steel washers under the heads.

PART 3 - EXECUTION

3.1 EQUIPMENT SUPPORTS
A. This Contractor shall provide all bases, concrete inserts, anchor bolts, and structural steel to support the equipment, ductwork, piping, etc installed by him. Any equipment legs, guy wire, anchors, etc., or any pipe that passes through the roof shall be sealed by a method approved by the Architect.

B. Provide concrete housekeeping pads a minimum of 3-½" high, unless detailed otherwise, under all equipment, pumps, etc., in equipment rooms that have piping containing water. The horizontal distance from the equipment support to the edge of the pad shall be at least 2", but not more than 4". All exposed edges of each pad shall be ½" chamfer and all surfaces shall be smooth. The housekeeping pads shall be reinforced with wire mesh and shall be doweled to the floor.

C. Plywood backboards shall be provided for all wall mounted equipment and controls (with the exception of surface mounted cabinets). Backboards shall be constructed of 3/4" plywood grade B-C. The "B" face shall be exposed. All boards shall be painted before attachment of any surface equipment.

D. Provide prefabricated roof curbs or rails for roof mounted equipment except where otherwise indicated on the drawings.

E. Curbs and rails shall be set on the roof structure and shall have a vertical insulation stop equal to the thickness of the roof insulation. (Field verify insulation for each curb and rail.) Install roof curbs and rails level and plumb, in accordance with manufacturer's written instructions. Coordinate with other elements of the work, including installation of roof deck, substrates, vapor barriers, roof insulation, roofing and flashing, as required to insure that the roof system is waterproof and weather tight.

1. Anchor curbs and rails securely to supporting structural substrates with bolts or by welding, adequate to withstand lateral and thermal stresses as well as inward and outward loading pressures.

2. Secure equipment to roof curbs with cadmium-plated screws or bolts or hardware approved by the Engineer. Install 3/8" thick sponge type gasket on top of curb to seal gaps between equipment and curb, unless otherwise approved by the Engineer.

3.2 PIPE STAND INSTALLATION

A. Pipe Stands: Details on the drawings show a low type support. In general, provide this type. Where the elevation of the roof changes or where the piping is required to slope, provide an adjustable type support that can accommodate the different support heights needed to maintain the proper pipe elevation above the roof.

B. Assemble components and mount on smooth roof surface. Do not penetrate roof membrane. Apply adhesive indicated on drawings between base and roof.

3.3 PIPE AND DUCT PROTECTION DURING CONSTRUCTION

A. Protect pipe and duct interiors with plastic plugs or plastic sheeting during construction to protect from moisture, construction debris and dust, and other foreign materials.

3.4 BUILDING OPENINGS FOR ADMISSION OF EQUIPMENT
A. Contractor shall ascertain from his examination of the architectural and structural drawings and the facility whether any special temporary openings or supports in the building for the admission of apparatus furnished under the Contract will be necessary. The Contractor shall pay all costs of making such openings or providing such supports.

3.5 CUTTING AND PATCHING

A. All cutting necessary for installation of the work and any required patching that results therefrom shall be done by the proper trade involved and shall be included in the work of this Contractor. Columns, beams, girders or other structural members shall not be cut. No openings shall be cut without written approval of the General Contractor.

B. Before cutting or drilling holes in floors, verify the location of reinforcing steel bars and embedded electrical conduits to avoid cutting same. X ray floors where necessary to verify such locations. Contact the Engineer before proceeding with cutting if such obstructions interfere with the locations of planned holes.

3.6 ROOF PENETRATIONS

A. Any penetration of the roof shall be provided with a roof curb, pitch pocket, or other appropriate roof penetration apparatus as herein described.

B. Cutting of the metal decking for all unframed openings is the responsibility of the Contractor requiring the opening. Cutting, patching and flashing of roof shall be the responsibility of the Contractor needing the opening. Roof cutting and patching shall be coordinated with the roof installer. The original roof warranty shall be maintained.

C. Roof mounted equipment shall be supported on roof curbs.

D. Piping penetrations shall be made using pipe portals in roof curbs.

E. When penetrations occur in new roofs, the installation of the roofing materials to the connection and the waterproofing of the roofing at the roof penetration apparatus shall be by the General Contractor. This Contractor shall schedule his work so all roof curbs, etc., are in place when required for installation of roofing.

F. At all times during construction, this Contractor shall provide temporary covers, enclosures, etc., required at roof openings to prevent injury to personnel and to prevent outdoor elements (water, wind, etc.) from entering the opening.

3.7 FLASHING:

A. Provide flexible flashing and metal counter flashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.

B. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed in accordance with manufacturer's instructions for sound control where indicated on the drawings.

3.8 ACCESS
A. All control devices, equipment, specialties, valves, plumbing traps, etc., shall be so located as to provide for easy access and proper clearance for operation, maintenance, and repair. Provide access panels where indicated or required.

B. Where items are located above non-accessible ceilings, in or behind walls, or in other similar concealed areas, contractor whose equipment requires access shall provide access panels.

C. Contractor shall obtain approval of Architect/Engineer of location of access panels that are not indicated on plans.

3.9 PAINTING

A. All pieces of mechanical equipment shall be factory finished machinery-grey or standard color as furnished by the manufacturer, or as called for in the technical section. Scratches shall be touched up in the field after equipment is installed with a paint which matches the original color.

B. All sheet metal plenums that are visible through an air device shall have the inside of the plenum painted flat black.

1. This Contractor shall paint the following items:
2. Paint ductwork visible behind air outlets and inlets matte black.
3. Paint exterior natural gas piping that is above grade; primer plus one coat yellow enamel.
4. No other painting is required unless specifically called for on the plans.

3.10 SLEEVES AND ESCUTCHEONS

A. This Contractor shall be responsible for locating, placing and maintaining in proper position all sleeves required for the work. In the event that failure to do so requires cutting and patching of finished work, it shall be done at this Contractor's expense.

B. Where pipes and ducts pass through fire walls, plaster or drywall shall be applied around the outside of the sleeve to seal between sleeve and wall.

C. The internal diameter/dimensions of sleeves shall be 1" to 2" larger than the outside diameter/dimensions of the pipe, duct or insulation. Insulation shall be continuous through sleeves except for ducts with fire dampers. This space is sufficient to allow some movement of the pipes or ducts without cracking the sealant.

D. The space between the pipes/ducts and the sleeve shall be sealed as follows:

1. Exterior walls above grade: Caulking shall be applied to a minimum 3" total depth. Sealant shall then be applied on both sides of the wall opening to a minimum ½" in depth, finishing flush with the wall.
2. Openings in floors or roofs: Caulking shall be applied from the upper side to a minimum depth of 3" recessed ½" below the finished floor or roof. This ½" recess shall then be filled with sealant to flush with finished floor or roof.
3. Interior Non-Rated Walls/Partitions:
a. Concealed locations: Limit the size of the space between the wall and the outside of the pipe or duct to 1" maximum. The space between the duct or pipe and the wall may be left open.

b. Visible Locations: Openings between duct and wall shall be covered with 24 gage galvanized steel sheet metal angles to form an escutcheon to cover the opening. Openings between pipes and wall shall be covered with chrome plated escutcheons.

4. Interior Fire-Rated Walls/Partitions/Floors/Ceilings:

a. Where pipes pass through rated assemblies (walls, floors, ceilings, etc.,) the pipes shall be sealed per approved methods to meet U.L. Classifications, see the details on the drawings.

b. Where ducts pass through fire rated interior assemblies (walls, floors, ceilings, etc.,) the ducts shall be connected to sleeves with fire dampers. See section 230900, Air Distribution and details on the drawings.

E. Shop drawings shall be submitted on all fire resistant materials and methods.

3.11 PIPING AND EQUIPMENT SYSTEMS MARKERS

A. All piping shall be identified with color coded banding. This color banding shall be applied at the following locations:

1. Adjacent to each valve.
2. At each branch or riser take-off.
3. Where piping goes through floors, walls or ceilings.
4. On horizontal pipe runs at 80 foot intervals, but not less than one per room.

B. Pipe marking shall also include printed markers indicating the service and flow arrows indicating direction of flow.

C. Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibs, and shut-off valves at plumbing fixtures. List each tagged valve in valve schedule for each piping system and include valve schedule in O & M Manual.

D. Provide equipment markers on all scheduled equipment. Provide manufacturer's standard laminated plastic markers. Provide approximate 2½" x 4" markers for control devices, dampers, and control valves; and 4½" x 6" for equipment. Include the A) Name and Plan Number and B) Equipment Service, matching terminology on schedules as closely as possible.

E. Install tape on top of all underground piping within 12" of grade. Locate markers as follows:

1. Continuously over all underground pipes.
2. Adjacent to each valve and fitting.
3. At each take-off.
4. At each pipe passage to underground.

END OF SECTION 230010
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SECTION 23 00 20 – VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide vibration isolators and seismic restraints as indicated for each type of equipment and for piping and duct systems. This section applies to:

1. HVAC System

1.2 SCOPE OF WORK

A. The following items of equipment shall have flexible duct connections installed at the ductwork connection to the equipment:

1. All air handlers, rooftop units, fan coils units, and variable volume terminals.
2. All exhaust fans, supply fans, relief fans and transfer fans.
3. Flexible duct connections are specified in Section 230900.

B. Unless otherwise noted on the equipment schedule, all mechanical equipment shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accordance with the weight distribution to produce reasonably uniform deflections.

C. All isolators and isolation materials shall be of the same manufacturer and shall be selected and certified using published or factory certified data. Any variance or non-compliance with these specification requirements shall be corrected by the contractor in an approved manner.

D. Vibration isolation and seismic control manufacturer shall have the following responsibilities:

1. Determine vibration isolation and seismic restraint sizes and locations.
2. Provide piping, ductwork and equipment isolation systems and seismic restraints as scheduled or specified.
3. Provide installation instructions and drawings.
4. Provide calculations to determine restraint loads resulting from seismic forces in accordance with the Local Building Code (see below), governing codes, project seismic requirements, or 0.5G minimum seismic acceleration applied at the equipment center of mass. Seismic calculations shall be certified by a licensed engineer, experienced in the design of restraints for flexibly mounted equipment.

E. Friction from gravity loads shall not be considered resistance to seismic forces.

F. Fire protection systems shall meet the requirements of NFPA-13 and NFPA-14 for the building seismic requirements.

G. All piping and ductwork shall to be restrained per the latest revision of the SMACNA "Seismic Restraint Manual Guidelines for Mechanical Systems", Second Edition, 1998. At a minimum, the seismic restraint manufacturer shall provide documentation on maximum restraint spacing for various cable sizes and anchors, as well as ‘worst case’ reaction loads at restraint locations.
1.3 RELATED DOCUMENTS

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

B. Section 230000 - Mechanical General Conditions.

C. Section 230010 - Basic Mechanical Material and Methods.

1.4 REFERENCES


1.5 DEFINITIONS


B. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.6 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading (Wherever loads are indicated, they shall apply only to outdoor equipment.)

1. Basic Wind Speed: 90 mph.
2. Assigned Occupancy Category or Building Category as Defined in the IBC: IV.
3. Minimum 10 lb/sq. ft. multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

B. Seismic-Restraint Loading:

1. Site Class as Defined in the IBC: C.
2. Assigned Occupancy Category or Building Category as Defined in the IBC: IV.
   a. Component Importance Factor: See Schedule on drawings.
   c. Component Amplification Factor: See Schedule on drawings.
3. Design Spectral Response Acceleration at Short Periods (0.2 Second): 0.430.
5. Seismic Design Category: D.

1.7 SUBMITTALS

A. Product Data: For the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic and wind (for outdoor equipment) forces required to select vibration isolators, seismic and wind (for outdoor equipment) restraints, and for designing vibration isolation bases.
   a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 23 Sections for equipment mounted outdoors.

2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.

3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.

4. Seismic and Wind-Restraint Details:
   a. Design Analysis: To support selection and arrangement of seismic and/or wind restraints. Include calculations of combined tensile and shear loads.
   b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
   c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Division 23 Sections for equipment mounted outdoors.
   d. Preapproval and Evaluation Documentation: By OSHPD or an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

C. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.
D. Welding certificates.

1.8 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings shall be based on independent testing. If preapproved ratings are not available, submittals shall be based on independent testing. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the products indicated on Drawings or a comparable product by one of the following:

1. Amber/Booth Company, Inc.
2. California Dynamics Corporation.
3. Isolation Technology, Inc.
5. Mason Industries.
7. Vibration Isolation.
8. Vibration Mountings & Controls, Inc.
9. Vibro Acoustics

B. Specification W: 3/4" thick waffle pad shall be made of standard neoprene and shall consist of 2" square modules separated by a thin web. Load distribution plate shall be used as required. Pads shall be Mason Type Super “W”.

C. Specification B: Spring type isolators shall be free standing and laterally stable without any housing and complete with 1/4" neoprene acoustical friction pads between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflections, compressed spring height and solid spring height. Mountings shall be Mason Type SLF.

D. Specification E: Vibration hangers shall contain a steel spring with a rod isolation bushing that passes through the hanger box. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing thru a 30 degree arc before contacting the
hole and short circuiting the spring. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include a scale drawing of the hanger showing the 30 degree capability. Hangers shall be Mason Type 30.

E. Specification RA: Pipe Riser Resilient Support Anchor. All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions. Anchors shall be Mason Type ADA.

F. Specification RG: Resilient Pipe Guides. Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements. Guides shall be Mason Type VSG.

G. Specification H: Double-deflection type, elastomeric hangers fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range. Hangers shall be Mason Type HD.

2.2 SEISMIC-RESTRAINT DEVICES

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. Amber/Booth Company, Inc.
2. California Dynamics Corporation.
3. Cooper B-Line, Inc.; a division of Cooper Industries.
4. Hilti, Inc.
7. Mason Industries.
8. TOLCO Incorporated; a brand of NIBCO INC.
9. Unistrut; Tyco International, Ltd.
10. Erico

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by OSHPD or an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least 4 times the maximum seismic forces to which they will be subjected.

C. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.

2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.

3. Maximum 1/4-inch air gap and minimum 1/4-inch thick resilient cushion.

D. Specification SB: Spring type isolators shall be free standing and laterally stable and complete with 1/4 inch neoprene acoustical friction pads or neoprene cup between the spring and the base plate. All mountings shall have leveling bolts. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflections compressed spring height and solid spring height. A steel housing shall be included to resist motion due to earthquake loads. A minimum clearance of 1/4 inch shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. The housing shall be out of contact during normal operations. Mountings used out of doors shall be hot dipped galvanized. Mounting shall be SSLFH or SLR as manufactured by Mason Industries, Inc.

E. Specification SC: Restraint Cables:

1. ASTM A 603 galvanized for interior locations and ASTM A 492 stainless for outdoor locations - steel cables with end connections made of galvanized/stainless steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement. Accessories shall be the same material as the cable. Mason Industries, Type SCB Seismic Slack Cables and Type SRC Seismic Rod Clamps.

2. Strut System: MFMA-3, shop or field-fabricated support assembly made of slotted steel channels (struts), 1-5/8 wide, in varying lengths and combinations to meet load capacities, with accessories for attachment to braced component at one end and to building structure at the other end and other matching components; and rated in tension, compression, and torsion forces. 12 gage channels unless otherwise indicated in the approved submittals. Cooper B-Line model B22 strut systems, pipe hangers, and accessories.

F. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod. Mason Industries Seismic Rod Clamps or B Line SC-228 or SC-UB Hanger Rod Stiffener.

G. Specification SG: Seismic Grommets. Resilient Isolation Washers and Bushings. One-piece, molded, oil- and water-resistant neoprene, with a flat washer face. The grommets shall be used with a steel washer between the bolt head (or nut if studs are used) and the grommet face. All anchor bolts shall be tightened until there is obvious grommet distortion and the bolt is torqued to 80% of allowable. In no case, shall the anchor bolt torque be less than 50% of the allowable. Mason Industries, Inc. Type HG.

H. Specification CC: Lay in ceiling fixture support clip designed to prevent an HVAC air device from lifting out of the ceiling grid during a seismic or hurricane event. Fit round or rectangular head tee bar. Complies with National electric Code Article 410-16 as a means of support for a light fixture. Painted finish. Erico - Caddy Clip model 515 or equal.
I. Specification SAB: Seismic Anchor Bolts.

1. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinccoated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter. Mason Industries, Inc. Type SAB.

2. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Mason Industries, Inc. Type SAA.

2.3 ROOF CURB ISOLATION SYSTEM - See 230010

2.4 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Interior Applications
   a. Baked enamel or powder coating for metal components.
   b. Color coding on springs to indicate capacity range.
   c. All hardware shall be electro-galvanized or cadmium plated.

2. Exterior Applications
   a. Hot-dip galvanized metal components except as otherwise indicated.
   b. Neoprene coating with color coding on springs to indicate capacity range.
   c. All hardware shall be electro-galvanized or cadmium plated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where required to prevent buckling of hanger rods due to seismic forces.
C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 INSTALLATION OF VIBRATION ISOLATORS

A. Except as otherwise indicated, comply with manufacturer's instructions for the installation and load application to vibration isolation materials and units. Adjust to ensure that units do not exceed rated operating deflections or bottom out under loading, and are not short-circuited by other contacts or bearing points. Remove space blocks and similar devices (if any) intended for temporary protection against overloading during installation.

B. Locate isolation hangers as near the overhead support structure as possible.

C. Adjust leveling devices as required to distribute loading uniformly onto isolators. Shim units as required where leveling devices cannot be used to distribute loading properly.

D. Install inertia base frames on isolator units as indicated to provide a minimum of 1 inch clearance when frame is filled with concrete and supported equipment has been installed and loaded for operation. Provide 3,000 psi concrete per section 230010 in accordance with manufacturer’s instruction to fill base.

E. Roof curbs and rails shall be set on the roof structure and shall be anchored securely to the supporting structural substrates with bolts. Anchoring shall be adequate to withstand static and dynamic loads as indicated in the Building Code indicated in Section 230000.

   1. Secure equipment to roof curbs and rails with cadmium-plated screws or bolts or other hardware approved by the Engineer unless otherwise indicated on the drawings.

F. The isolation type scheduled shall be provided for the each type of equipment. (Isolators identified as “With Equipment” shall be furnished as an accessory with the equipment and shall be installed by the equipment manufacturer such as for internally isolated air handlers.)

3.4 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Comply with requirements in Section 230010 for installation of roof curbs, equipment supports, and roof penetrations.

B. Equipment Restraints:

   1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
   2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
   3. Install seismic-restraint devices using methods approved by the manufacturer, the Engineer and the approved submittals for the component.

C. Piping and Ductwork Restraints:

   1. Comply with requirements in MSS SP-127 for piping

3. Space lateral supports and longitudinal supports at no more than the maximum of spacing indicated on the drawings or the local building code.

4. Brace a change of direction as indicated on the drawings or the local building code.

D. Install cables so they do not bend across edges of adjacent equipment or building structure.

E. Cables shall be installed with sufficient slack to avoid short circuiting the vibration isolators. Attachment brackets at each end of the cable shall permit free cable movement in all directions up to a 45-degree misalignment. Protective thimbles shall be used at sharp connection points. Attachment bolts and anchors shall exceed the design load of the wire cable by a minimum of 50 percent. Single sided “C” beam clamps shall not be allowed. Wire rope connectors shall be approved by the wire rope manufacturer. Vertical suspension rods shall be braced to avoid buckling due to up forces.

F. Install seismic-restraint devices using methods approved by the manufacturer, the Engineer and the approved submittals for the component.

G. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

H. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

I. Attachment to Structure: Attachments shall be as indicated on the drawings and the approved submittals. If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

J. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the Architect, Engineer, and Structural Engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.

4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.

5. Set anchors to manufacturer’s recommended torque, using a torque wrench.

6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.
3.5 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.

3.6 ADJUSTING

A. Adjust isolators on piping after piping system is at operating weight.

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

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 230020
SECTION 23 01 00 – INSTALLATION OF MECHANICAL PIPING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish all labor, material, services and related items for the HVAC water systems shown on the plans and/or specified herein. These systems shall include:

1. Condensate Drains
2. Refrigerant Piping
3. Natural Gas

1.2 RELATED DOCUMENTS

A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.

B. Section 230000 - Mechanical General Conditions.

C. Section 230010 - Basic Mechanical Materials and Methods.

D. Section 230020 - Vibration Isolation and Seismic Restraints.

E. Section 230200 - Mechanical Insulation.

F. Section 230910 - Start-up, Cleaning and Testing.

G. Section 230930 - Testing and Balancing.

H. Section 230960 - Temperature Controls.

1.3 REFERENCES

A. ANSI/ASME Sec 9 - Welding and Brazing Qualifications.

B. ANSI/ASME 31.9 - Building Services Piping.


1.4 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body.


C. Welders Certification: In accordance with ANSI/ASME Sec 9.


1.5 SUBMITTALS

A. Submit the following in accordance with Section 230000.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

19-2726.01 & INSTALLATION OF MECHANICAL PIPING 23 01 00 - 1
19-2727.01
A. Hangers and support components shall be factory fabricated of materials, design, and manufacturer complying with MSS SP-58 except as modified herein.

1. Hangers: Types 5 and 12 shall not be used.
2. Hangers: Type 3 shall not be used on insulated piping.
3. C-Clamps: Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.
4. Angle Attachments: Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.
5. Hangers: Type 24 shall be used only on trapeze hanger systems or on fabricated frames.

B. Components shall have galvanized or cadmium plated coatings where installed for piping and equipment that will not have field-applied finish.

C. Pipe supports shall be compatible with the pipe being supported to prevent galvanic corrosion. All supports for copper piping shall be copper coated hangers conforming in general to the above specification. Where copper pipes are separated from hangers by pipe insulation, hangers do not need to be copper coated.

D. Saddles and hangers for insulated piping:

1. Type 39 saddles shall be used on all insulated pipe 12 inches and larger when the temperature of the medium is above 60 degrees F. Type 39 saddles shall be welded to the pipe.
2. Type 40 shields shall:
   a. be used on all insulated pipes less than 12 inches.
   b. be used on insulated pipes larger than 12 inches when the temperature of the medium is 60 degrees F or less.
   c. have a wooden insert for pipes 2 inches and larger, and for smaller pipe when the insulation shows signs of being visibly compressed, or distorted. Insulation jacket shall be sealed at the insert to provide continuity of the vapor barrier.

   1) In lieu of the wooden blocks, this Contractor may provide rigid insulation saddle, equal to Fee and Mason Fig. 71, consisting of rigid urethane foam insulation with vapor barrier jacket and thermal conductivity of 0.13 BTU/HR/FT²/°F/IN @ 75°F. Insulation saddle length shall be 6" for pipes 6" and smaller. Thickness shall be the same as pipe insulation.
   d. distribute the loading on the bearing area of the insulation in accordance with the following minimum dimensions covering 180° of arc:

<table>
<thead>
<tr>
<th>PIPE SIZE (INCHES)</th>
<th>GALVANIZED IRON SADDLE LENGTH (INCHES)</th>
<th>GAUGE THICKNESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 to 4</td>
<td>12</td>
<td>16</td>
</tr>
<tr>
<td>6</td>
<td>18</td>
<td>16</td>
</tr>
<tr>
<td>8 and 10</td>
<td>24</td>
<td>14</td>
</tr>
</tbody>
</table>
E. The hangers or supports for piping with vapor barriers shall be located outside the insulation and the vapor barrier must be left undisturbed for pipes 10 inches and smaller.

F. Pipe supports shall be equal to B-Line model numbers hereinafter listed. Equal products by Unistrut or Grinnell are acceptable. (Grinnell numbers are shown in parentheses)

1. Clevis Hanger Fig. B 3100 or B3104 (260 or 65)
2. Adjustable Swivel Ring Fig. B 3170 (9)
3. Adjustable Swivel Roller Fig. B 3110 (181)
4. Adjustable Roller Support Fig. B 3114 or Fig. B 3122 ((171 OR 177)
5. Riser Clamp (Standard Duty) Fig. B 3373 (261)
6. Riser Clamp (Heavy Duty) Fig. (40)
7. Offset Clamp Fig. B 3148 (103)
8. Wall Bracket (Light Duty) Fig. B 3068 (194)
9. Wall Bracket (Medium Duty) Fig. B 3065 (195)
10. Stand with Base Fig. B 3088 or Fig. B 3088T (62 OR 63)
11. U-Bolts Fig. B 3188 (137)
12. Structural Attachments:
   Beam clamps: B 3031(92), B 3033(93), B 3034(94), B 3050(133), B 3045(217) and retaining straps for seismic applications
   Angle Iron Beam Clamp: B 3046
   Bar Joist: B 3059
   Concrete Inserts: B 2500 (281), B 2505 or 2506(285), or B 3014(282)
   Drilled Inserts: Phillips Red-head, wedge anchors

2.2 MISCELLANEOUS MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36.

B. Pipe Alignment Guides: Factory fabricated, of cast semi-steel or heavy fabricated steel, consisting of bolted two-section outer cylinder and base with two-section guiding spider that bolts tightly to pipe. Length of guides shall be as recommended by manufacturer to allow indicated travel.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING

A. All pipe shall be run parallel to or at right angles to walls, beams or columns. Pipe shall be run as direct as possible, avoiding unnecessary offsets, and maintaining maximum headroom. Shortcut diagonal methods will not be allowed.

B. Piping drawings are to be considered schematic and are not intended to indicate all changes in direction and necessary fittings to be furnished and installed. Provide reducers/increasers at connections to equipment as required to match the equipment. Pipe and fittings shall be installed so that all pipe and/or insulation completely clears all nearby structures and piping.

C. All piping shall be supported from the building structures by means of approved hangers and supports. Piping shall be supported to maintain required grading and pitch of lines, to prevent vibration and excessive deflections, and to secure piping in place.
D. Piping shall be arranged to allow for expansion and contraction. Provide expansion loops, guides and anchors where indicated on the drawings.

E. Install branch connections to mains using Tee fittings in main with take-off out the bottom of the main, except for up-feed risers which shall have take-off out the top of the main line except branch take-offs shall be made with swing connections where required to avoid stress at these points. Tees shall not be installed in a bullhead arrangement.

F. At swing connections, offsets, expansion loops, etc., pipes shall be cold sprung into place before welding to compensate for fifty percent (50%) of the expansion.

G. Pipes shall not be hung from other piping or from equipment of other trades. Hanger rods and piping shall not pierce ductwork.

H. Pipe supports shall be structurally capable of carrying the pipe or pipes supported by them and shall be capable of vertical adjustment after installation of piping.

I. Piping at all equipment and control valves shall be supported to prevent strains or distortions in the connected equipment and control valves. Piping shall be installed and supported to allow for removal of equipment, valves and accessories with minimum dismantling and without requiring additional supports after these items are removed.

J. Install unions in pipes 2-1/2 inch and smaller at final connections to each piece of equipment and at valves, strainers, traps, etc., and elsewhere as indicated. Unions are not required on flanged devices. Install flanges on valves, apparatus, and equipment having 3 inch and larger connections.

K. Dissimilar metals in the piping system shall be separated with dielectric unions or insulating flange sets.

L. Factory fabricated fittings, similar to Bonney Forge Weldolet, Threadolet, Socklolet, or Elbolet may be used for branch connections to mains where branch size is less than main's size.

M. Welding shall be performed by individuals who are currently qualified under procedures certified as acceptable by the National Certified Pipe Welding Bureau. Individuals must be prepared to provide current qualification certificates upon request. All work shall be done in accordance with the latest revised edition of the ASME Code for Pressure Piping requirements.

N. Lines subject to rapid changes in flow rate shall be anchored to prevent excessive movement or vibration.

O. Drain lines shall be terminated over floor drains to direct the flow vertically into the floor drain. Provide elbows where required. Cut openings in the floor drain strainer where needed to prevent splash-out. Provide clean outs at changes in direction of more than 45 degrees and at maximum 75 feet spacing along the line.

3.2 PIPE JOINT CONSTRUCTION

A. Soldered Joints: Comply with the procedures contained in the AWS "Soldering Manual."

B. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."
1. **CAUTION:** Remove stems, seats, and packing of valves and accessible internal parts at piping specialties before brazing.

2. Fill the pipe and fittings during brazing, with an inert gas (ie., nitrogen or carbon dioxide) to prevent formation of scale.

3. Heat joints using oxy-acetylene torch to proper and uniform temperature.

C. **Threaded Joints:** Conform to ANSI B1.20.1, tapered pipe threads for field cut threads. Join pipe fittings and valves as follows:

1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.

2. Align threads at point of assembly.

3. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).

4. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

   a. **Damaged Threads:** Do not use pipe with threads which are corroded or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.

D. **Welded Joints:** Comply with the requirement in ASME Code B31.9-"Building Services Piping."

E. **Flanged Joints:** Align flanges surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

F. **Grooved Joints:** Assemble joints in accordance with fitting manufacturers written instructions.

G. **Press-Joint Fittings:** Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B 16.22 and performance criteria of IAPMO PS 117. All copper press fittings, couplings and specialties shall be the products of a single manufacturer. Installation tools shall be as recommended by the fittings manufacturer.

### 3.3 INSTALLATION OF HANGERS AND SUPPORTS

A. Install hangers, supports, clamps and attachments, complete with necessary inserts, bolts, rods, nuts, washers, and other accessories, to support piping from building structure; comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping supported together on field-fabricated, heavy-duty trapeze hangers where possible. Install supports with maximum spacings complying with MSS SP-58.

B. Install building attachments within concrete or to structural steel. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through openings at top of inserts. Where inserts are omitted, drill through concrete slab and provide thru-bolt with recessed square steel plate and nut recessed into and grouted flush with slab in locations where nut, etc. will interfere with other work or be a tripping hazard and above slab in other locations.
C. Hangers and supports shall be provided as required to eliminate vibration and excessive deflection, but in no case over the following centers, unless specifically indicated otherwise on the drawing. Rod sizes for individual pipe lines shall not be less than the following schedule:

(\text{STL} = \text{Steel}, \ \text{CU} = \text{Copper})

<table>
<thead>
<tr>
<th>PIPE SIZE (INCHES)</th>
<th>MAXIMUM HANGER SPACING (FEET)</th>
<th>MINIMUM HANGER SPACING (FEET)</th>
<th>MINIMUM ROD SIZE (INCHES)</th>
<th>MINIMUM ROD SIZE (INCHES)</th>
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<tbody>
<tr>
<td>(1/2)</td>
<td>7</td>
<td>3/8</td>
<td>5</td>
<td>3/8</td>
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<tr>
<td>(1)</td>
<td>7</td>
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<td>3/8</td>
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<tr>
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<tr>
<td>(2)</td>
<td>10</td>
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<td>3/8</td>
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<tr>
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<tr>
<td>(16)</td>
<td>27*</td>
<td>1</td>
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</table>

*Maximum spacing for insulated pipe shall be 20 feet.

1. An additional hanger shall be installed at every change in direction of piping.

D. When trapeze type hangers are used to support two or more pipes, rods shall be used for vertical hanger members and angles, channels, Unistrut or tee sections for horizontal hanger members. The material used shall be sized to support the load without excessive deflection. Spacing of trapeze hangers shall be based on the smallest pipe supported on the trapeze hanger. Rod sizes and spacing for trapeze hangers shall be based on supported weight and load carrying capacity of attachment device. Size trapeze bar for allowable loads indicated in SMACNA HVAC Duct Construction Manual (2005), Table 4-3, or as otherwise approved by the Engineer.

E. Hanger rods shall have double nuts and lockwashers at all connections.

F. Piping at walls shall be supported with wall brackets; vertical pipes shall be supported with riser clamps.

G. Contractor shall verify loading on hangers, hanger rods and structural attachments. Loading on the assembly shall not exceed 75% of the manufacturer's rating for any component of the assembly. If loading does exceed the 75%, then hanger spacing shall be reduced.
H. Piping shall not be supported from joist bridging or a roof metal deck.

I. Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves. Pipe hanger loads in excess of 50 pounds, suspended from steel joists, shall have the hanger loads suspended from panel points. Pipe supports for PVC piping shall be maximum 4 feet on centers. Where local codes require closer spacing than indicated on the plans or specifications, the supports shall conform to the local code requirements. For buildings built with steel joists before 1985, pipe supports shall be attached to the top leg of the joist.

J. Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 15 feet, not more than 8 feet from end of risers, and at vent terminations.

K. Pipe Guides: Type 35 guides using steel reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

L. Steel Slides: Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 4 inches and larger with medium 60 degrees F or greater, a Type 39 saddle may be welded to the pipe and freely rest on a steel plate. On piping under 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

M. High Temperature Guides with Cradles: Where there are high system temperatures and welding to piping is not desirable, the Type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 4 inches, or by an amount adequate for the insulation, whichever is greater.

3.4 Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals. Pipe sleeves smaller than 6 inch shall be steel; pipe sleeves 6-inch and larger shall be sheet metal. See additional requirements in Section 230010.

3.5 Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings, and floors, maintain the fire rated integrity. Refer to Section 230010 for sealants and materials.

3.6 Provide seismic bracing in accordance with Section 230020 and details shown on drawings for piping and specialties where indicated or required by the local building code.

3.7 Provide thermometers, thermometer sockets, and thermal wells where indicated on the drawings or in the specifications. Install in tees or in extra heavy nipples welded to the pipe or as indicated on the drawings. Install thermal wells for temperature control system temperature sensors (furnished under Section 230960 - Temperature Control Systems) and where indicated on the drawings. Coordinate the location of temperature sensor wells with the temperature control contractor and the Engineer.

3.8 Install control valves and pressure sensors in accordance with the manufacturer’s instructions where indicated on the drawings or in the specifications. Install taps and shut off valves for
pressure sensors for temperature control system sensors (furnished under Section 230960 - Temperature Control Systems) and where indicated on the drawings.

3.9 Provide pressure gauges and test plugs where indicated on the drawings or in the specifications.

3.10 Dielectric unions shall be provided at the following locations:

A. At the connection of copper and steel piping.
B. At the connection of steel piping to copper coils.

END OF SECTION 230100
SECTION 23 01 40 – NATURAL GAS PIPING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK
A. Furnish all labor, material, services and related items necessary to complete the natural gas piping work indicated on the drawings and/or specified herein. Work to be performed shall include, but not be limited to, the following items:
   1. Installation of all natural gas piping including connections to all equipment.
   2. Connections to the utilities gas meter including all utility service requirements.
B. Contractor shall arrange with the gas company to extend a natural gas service to the site at the location shown. The cost of this natural gas service shall be included in this contractor's bid.

1.2 RELATED DOCUMENTS
A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.
B. Section 230000 - Mechanical General Conditions.
C. Section 230010 - Basic Mechanical Materials and Methods.
D. Section 230020 - Vibration Isolation and Seismic Restraints.
E. Section 230100 - Installation of Piping.
F. Section 230910 - Start-up, Cleaning and Testing.

1.3 SUBMITTALS
A. Submit product data for each gas piping, specialty and valve under provisions of Section 230000. Include rated capacities of selected models, furnished specialties and accessories, and installation instructions.
B. Shop drawings detailing dimensions, required clearances, for connection to gas meter.
C. Maintenance data for gas specialties and valves, for inclusion in operating and maintenance manual specified in Section 230000.
D. Welders' qualification certificates, certifying that welders comply with the quality requirements specified under "Quality Assurance" below.

1.4 QUALITY ASSURANCE
A. Codes and Standards
   1. Applicable local, state and national codes.
   2. NFPA Pamphlet 54A and 54
   3. Rules and regulations of the local utility company.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Pipe - Carbon steel pipe ASTM-A53 continuous electric weld or seamless, Schedule 40.


C. Weld Fittings - Seamless carbon steel Grade B standard weight butt weld fittings, ASA B16.9, material ASTM A-234.


E. Flanges - Forged carbon steel bored to match Schedule 40 pipe, 150 lb., ASA B16.5, raised face, slip-on, materials ASTM A-181, Grade 1.

F. Underground Piping - Material shall be the same as above ground piping with factory applied polyethylene coating. "X-TRU-COAT" by Republic Steel or equal. Joints and any damage to coating shall be repaired with "X-TRU-TAPE" and primer or equal.

G. Alternate Underground Piping

1. Contractor may use Polyethylene tubing for underground service conforming to ASTM D-2513, SDR-11.
2. Provide an anodeless riser to transition to steel piping above grade for service terminations, Wayne Manufacturing or approved equal. Riser shall have a slip on moisture seal, a stainless steel tracer wire connection and an epoxy coating. Riser shall be pre-bent to 90 degrees and shall have minimum 18 inches cover over horizontal, underground branch pipe.
3. Where polyethylene tubing is used, a 12 gage, yellow tracer wire shall be installed along with the tubing and tubing shall be placed on a 6 inch bed of sand.
4. Provide a 1-1/2" diameter galvanized steel, schedule 40 post with a U-bolt to support the risers at grade. Post shall be 4 feet long and shall be buried 3 feet below grade.

2.2 VALVES AND SPECIALTIES

A. Gas cocks shall be "Lubroseal" by Mueller Company or approved equal. Use threaded cocks in threaded piping and flanged cocks in welded pipe. Gas cocks shall be bronze body with AGA stamp, plug type with bronze plug and flat or square head, ball type with chrome-plated brass ball and lever handle, or butterfly valve with stainless-steel disc and fluorocarbon elastomer seal and lever handle; 125 psig minimum pressure rating. Include feature for locking.

B. Insulating unions shall be Eclipse Wedge Seal or approved equal. Insulation flanges shall have Type FNDW gasket set as manufactured by F. H. Maloney Company or approved equal. Install unions or flanges where shown on drawings and whether shown or not, at entrance to building.
C. Electrically Operated Gas Valves: UL 429, bronze, aluminum, or cast-iron body solenoid valve; 120 Vac, 60 Hz, Class B, continuous-duty molded coil. Include NEMA ISC 6, Type 4, coil enclosure and electrically opened and closed dual coils. Valve position shall normally be closed. If an electrically operated gas valve is required, it shall be U.L. Listed for use with the kitchen fire suppression system which it is connected to and shall operate by using a micro switch and a U.L. listed manual reset relay.

2.3 GAS PRESSURE REGULATORS

A. Gas pressure regulators shall be provided for all gas-fired equipment. Equal products by the following manufacturers are acceptable:

1. Maxitrol, Inc.
2. American Meter Co.
3. Actaris Metering Systems
7. Schlumberger Industries; Gas Div.

B. Gas pressure regulators shall be adjustable, spring compression, single stage and suitable for natural gas fuel service. Include steel jacket, corrosion-resistant components, elevation compensator, and atmospheric vent. Regulators for outside service shall be rated for such use.

1. Natural gas distribution system within the building has been based on a 11 IN. W.C. delivery pressure at the meter.
2. Pipe Connections:
   a. NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
   b. NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.
3. Service Pressure Regulators: ANSI Z21.80. Rated for pounds to pounds service with inlet pressure of 100 psig and outlet pressure of 2 psig. American Meter 1200 Series or as approved by the local Gas Utility company.
4. Appliance Pressure Regulators: ANSI Z21.18 with 2 psig inlet pressure rating and outlet pressure of 7 to 11 inches WC. Regulator may include vent limiting device, instead of vent connection, if approved by Authorities Having Jurisdiction. Maxitrol model 325 or equal.

C. Pressure Regulator Vents: Factory- or field-installed, corrosion-resistant screen in opening if not connected to vent piping.

2.4 FLEXIBLE GAS CONNECTORS

A. Flexible gas connectors shall comply with the following:
1. Bronze metal braided, bellows type, screwed or flanged, unbraided working pressure rating of 45 psig at a maximum service temperature of up to 175°F. End fittings factory welded to hose.
2. Suitable for natural gas.
3. Connector length shall be no greater than 24".
4. Manufactured by Flexonics, Anaconda, or Metalflex.

2.5 PRESSURE GAUGES

A. Manufacturer: Subject to compliance with requirements, provide hydronic piping system products from one of the following:
   1. Marsh
   2. Weiss
   3. U.S. Gauge
   4. Weksler
   5. Trerice

B. Gauges shall be equal to Trerice #800B.

C. Gauges shall include the following:
   1. 1-1/2" diameter
   2. Drawn steel, black case
   3. Styrene acrylonitrile window
   4. ABS plastic white dial face with black graduations
   5. Bronze tube, Bourdon Type
   6. Brass movement
   7. 1/4" NPT bottom connections with brass tee handle cock.

D. Submit shop drawings on gauges.

E. Graduation of pressure gauges shall be:

<table>
<thead>
<tr>
<th>RANGE</th>
<th>DIVISIONS</th>
<th>FIG. INTERVAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas</td>
<td>0 – 15 psi</td>
<td>0.5 psi</td>
</tr>
</tbody>
</table>

F. Gauge cocks shall be brass, equal to Trerice No. 865 or 880, and shall be provided at all gauges.

PART 3 - EXECUTION

3.1 INSTALLATION – GENERAL

A. See Section 230100 for general piping installation.

B. Comply with ANSI Z223.1, "Prevention of Accidental Ignition".

C. Contractor shall extend gas piping to all gas fired equipment. A gas cock shall be provided at each item.

D. Gas cocks shall be provided upstream of all gas pressure regulators.
E. Dirt legs shall be provided at the connection to all gas fired equipment.

F. Thread sealing compound compatible with service shall be used on all threaded joints.

G. Gas piping above ground, not in concealed spaces, 3" and smaller shall be either threaded or welded.

H. Gas piping 3-1/2" and over shall be welded.

I. All gas piping in concealed spaces shall have joints welded or pipe shall be run in sealed EMT conduit with both ends vented to the outside of the building. The following gas piping shall be considered concealed:
   1. Piping located in walls.
   2. Piping located in any non-ventilated space.

J. Contractor shall extend all gas train vents to and terminate outside the building. Vents shall terminate with screened vent elbow turned down. Each vent connection shall be individually extended to outdoors.

K. Flexible connectors shall be used only where specifically called for on the plans. Do not install flexible connectors where prohibited by local code.

L. Seismic Bracing
   1. Seismically brace all gas piping in compliance with Section 230020 - Vibration and Seismic Controls for HVAC Piping and Equipment and the local building code.

3.2 PRESSURE REGULATOR INSTALLATION

A. Install pressure regulators in accordance with manufacturer’s written installation instructions.

B. Regulators installed outdoors shall have a factory furnished vent protector to protect breather hole from rain snow and insects. Or contractor may provide full size pipe and elbows turned down with screened outlet terminated a minimum of 2'-0" above roof or ground.

C. For vented regulators installed inside the building, extend vent to outside of building or enclosure. Vent pipe shall be turned down, terminated a minimum of 2'-0" above roof or ground with screened vent elbow. Size of vent line shall be not less than 3/4". Where required by regulator manufacturer, increase the size of the vent line to prevent excessive back pressure on the regulator. Where there is more than one regulator at a location, each regulator shall have a separate vent to the outside unless a manifold vent is permitted by the Authorities Having Jurisdiction. Manifolds shall be in accordance with accepted engineering practices to minimize back pressure.

3.3 SERVICE ENTRANCE PIPING

A. Confirm with utilities that exterior fuel gas distribution system piping, service pressure regulator and service meter will be provided by gas utility.

B. Extend fuel gas piping and connect to fuel gas distribution for service entrance to building.
C. Install dielectric fitting downstream from and adjacent to each service meter unless meter is supported from service-meter bar with integral dielectric fitting. Install shutoff valve downstream from and adjacent to dielectric fitting.

3.4 SERVICE-METER ASSEMBLY INSTALLATION

A. Coordinate with Gas Utility Company for installation of service-meter assemblies.

3.5 ADJUSTING

A. Adjust controls and safety devices. Replace damaged and malfunctioning controls and safety devices.

END OF SECTION 230140
SECTION 23 01 50 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Furnish all labor, material, services and related items necessary for the refrigerant piping systems shown on the plans and as specified herein. These systems shall include:

1. Refrigerant Piping
2. Refrigerant
3. Refrigerant Piping Specialties

B. Coordinate refrigerant pipe size with refrigerant component manufacturer.

1.2 RELATED DOCUMENTS

A. All applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.
B. Section 230000 - Mechanical General Conditions.
C. Section 230010 - Basic Mechanical Materials and Methods.
D. Section 230020 - Vibration Isolation and Seismic Restraints.

1.3 REFERENCES

B. ANSI/ASHRAE 34 - Number Designation of Refrigerants.
E. ANSI/ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
F. ANSI/ASME B31.5 - Refrigeration Piping.
G. ANSI/ASME B31.9 - Building Services Piping.
H. AWS - Brazing.
I. ANSI/ASTM B88 - Seamless Copper Water Tube.
J. ANSI/AWS A5.8 - Brazing Filler Metal.

1.4 REGULATORY REQUIREMENTS

A. Conform to ANSI/ASME B31.9.
B. Welding Materials and Procedures: Conform to ANSI/ASME SEC 9 and applicable state labor regulations.
C. Welder’s Certification: In accordance with ANSI/ASME SEC 9.

1.5 SUBMITTALS

A. Provide submittals in accordance with Section 230000 - Mechanical General Conditions.
B. Submit shop drawings indicating isometric layout of system, including equipment, critical dimensions, and sizes.
C. Submit product data indicating general assembly of specialties, including manufacturer’s catalog information.

D. Submit manufacturer's installation instructions under provisions of Section 230000.

E. Submit test reports indicating results of leak test, acid test.

F. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring.

1.6 DELIVERY, STORAGE, AND HANDLING

A. All refrigerant and refrigerant oil shall be delivered to the site in factory sealed containers.

B. Deliver and store piping and specialties in shipping containers with labeling in place.

C. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.

PART 2 - PRODUCTS

2.1 REFRIGERANT PIPE AND FITTINGS

A. Piping: Copper Tubing, ASTM B280, Type ACR, hard drawn, factory cleaned, dehydrated and pre-charged with nitrogen. “ACR” as manufactured by Mueller Brass Company or equal.

B. Fittings: ANSI/ASME B16.22 wrought copper or forged brass.

C. Joints: AWS Classification BAg-1 (silver). Mueller Brass No.122 solder and silver brazing flux or equal. All joints shall be brazed with a constant bleed of nitrogen to prevent formation of oxide or scale.

2.2 REFRIGERANT LINE KITS

A. Annealed-copper suction and liquid lines factory cleaned, dried, pressurized with refrigerant, sealed, and with suction line insulated. Provide in standard lengths for installation without joints, except at equipment connections.

   1. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I, 3/8 inch thick.

2.3 REFRIGERANT SPECIALTIES

A. Manufacturers: One manufacturer has been listed with the various specialties to establish desired type. Equal product of the following manufacturers are acceptable.

   1. Expansion valves, solenoid valves, filter driers, moisture and liquid indicators.

      a. Alco Valve Company
      b. Sporlan Company
      c. Mueller Brass

   2. Valves, strainers, check valves, relief valves.
a. Mueller Brass  
b. Henry Valve Company  
c. Superior Valve Company  
d. Vilter  
e. York  

3. Receivers  
   a. Standard Refrigeration  
   b. Vilter  
   c. E. L. Nickel  

4. Flexible Connectors  
   a. Resistoflex  
   b. Flexonics  
   c. Keflex  
   
B. Shut off Valves: Packed, back seating type with seal cap and arranged for straight through flow. Valves shall be full line size with renewable seats, brass body. Capable of being re-packed under line pressure. Rated for maximum working pressure of 500 psi and maximum temperature of 275 degrees F. Mueller Brass "Globemaster".  

C. Filter Driers:  
   1. Sealed type: "Catch-All" by Sporlan Valve Company. UL listed. Size of drier as recommended by manufacturer with a maximum drop of 1 PSI. Rated for maximum working pressure of 350 psi.  
   2. Replaceable Cartridge Angle Type: ANSI/ARI 710, UL listed, brass shell and bronze cap, perforated brass shell and molded desiccant filter core; size of drier as recommended by manufacturer with a maximum drop of 1 PSI. Rated for maximum working pressure of 350 psi.  

D. Sight Glasses: Liquid and moisture indicating type, "Eye-Spy" by Alco Valve. Full line size. Where line size is larger than standard sight glass size, install in bypass line using manufacturer's bypass kit in accordance with manufacturer's recommendations.  

E. Solenoid Valves: ARI 760, pilot operated, copper or brass body and internal parts, synthetic seat, stainless steel stem and plunger assembly, with solder ends; for maximum working pressure of 500 psi. Stem shall permit manual operation in case of coil failure. Coil Assembly: UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, with integral junction box; ANSI/UL 429.  

F. Expansion Valves: ARI 750; design suitable for refrigerant, brass body, internal or external equalizer, bleed hole, adjustable superheat setting, replaceable inlet strainer, with non-replaceable capillary tube, remote sensing bulb and remote bulb well.  
   1. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure
and minimum 10 degrees F superheat. Select to avoid being undersized at full load and excessively oversized at part load.

G. Strainers: Brass shell, cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass; for maximum working pressure of 430 psi.

H. Check Valves:
   1. Globe Type: Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, teflon seat disc; for maximum working pressure of 500 psi and maximum temperature of 300 degrees F.
   2. Straight Thru Type: Brass body and disc, phosphor-bronze or stainless steel spring, neoprene seat; for maximum working pressure of 500 psi and maximum temperature of 200 degrees F.

I. Pressure Relief Valves: Straight Thru or Angle Type: Brass body and disc, neoprene seat, factory sealed and stamped with ASME UV and National Board Certification NB; for standard 235 psi setting; selected to ANSI/ASHRAE 15.

J. Receivers:
   1. Internal Diameter 6 inch and Smaller: ANSI/ARI 495, UL listed, steel, brazed; 400 psi maximum pressure rating, with tappings for inlet, outlet, and pressure relief valve.
   2. Internal Diameter Over 6 inch: ANSI/ARI 495, welded steel, tested and stamped in accordance with Section 8D of the ANSI/ASME Boiler and Pressure Vessels Code; 400 psi with tappings for inlet, outlet and pressure relief valve.

K. Flexible Connectors: Corrugated stainless steel hose with single layer of stainless steel exterior braiding, minimum 9 inches long with copper tube ends; for maximum working pressure 500 psi.

L. Refrigerant: R-410A.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Install piping as shown on the plans with no additional bends or offsets. If a conflict occurs between refrigerant piping and other building components, notify the Engineer for resolution before proceeding.

B. Piping may be pre-insulated line sets if approved by the manufacturer of the condenser, condensing unit, evaporator, and other refrigeration components. On VRF systems, line sets are only allowed downstream of branch selector boxes.

C. If refrigerant pipe sizes are not shown on the plans, sizing and routing shall be in accordance with the refrigerant component manufacturer’s recommendations. If refrigerant pipe sizes are shown on the plans, verify refrigerant pipe sizing and routing with the manufacturer of the condenser, condensing unit, evaporator, and other components PRIOR TO THE INSTALLATION of any piping and report to the Engineer if the sizes or routing are in conflict with the
D. All components of the refrigerant system shall be designed for the type of application, refrigerant, and the system pressures encountered. All components, methods of installation, testing procedures, etc., shall be in accordance with all applicable codes.

E. Hanging and supporting of refrigerant piping shall be as specified in Section 230100, Installation of Piping.

F. Pitch piping in the direction of flow with no pockets or traps other than those indicated on the plans. Oil traps that are indicated shall be made as small as possible and still retain the intended function.

3.2 INSTALLATION OF REFRIGERANT SPECIALITIES

A. Install refrigeration specialties in accordance with manufacturer’s instructions.

B. Filter Driers

1. Provide permanent filter-driers in low temperature systems, systems utilizing hermetic compressors, and where indicated.
2. Provide replaceable cartridge filter-driers vertically in liquid line adjacent to receivers.
3. Provide replaceable cartridge filter-driers, with three-valve bypass assembly.
4. Provide filter-driers for each solenoid valve.

C. Sight Glasses

1. Provide sight glasses ahead of all solenoid valves and where indicated.
2. Provide line size sight glasses in main liquid line leaving condenser, or if receiver is provided, in liquid line leaving receiver.

D. Solenoid Valves

1. Provide solenoid valves in liquid line of systems operating with single pump-out or pump-down compressor control, in liquid line of single or multiple evaporator systems, in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into the suction line when system shuts down, and where indicated.
2. Provide electrical connection to solenoid valves.

E. Expansion Valves

1. Provide expansion valves in liquid line at each connection to DX coils (distributor) and where indicated.
2. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
3. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.

F. Strainers
1. Provide line size strainer upstream of each automatic valve. Where multiple expansion valves with integral strainers are used install single main liquid line strainer.

G. Shut Off Valves
1. Provide shut-off valves on each side of strainer and where indicated.
2. Provide refrigerant charging (packed angle) valve connections in liquid line between receiver shut-off valve and expansion valve.

H. Check Valves: Install where indicated.
I. Relief Valves: Install where required by code and where indicated.
J. Receivers: Install where indicated.
K. Flexible Connectors
1. Utilize flexible connectors at or near compressors where piping configuration does not absorb vibration and where indicated.
2. Install flexible connectors at right angles to axial movement of compressor.

3.3 TESTING
A. Testing for pre-charged refrigerant line kits is not required.

B. When installation of field installed refrigerant piping and fittings is complete, disconnect and cap all lines to gauges, controllers, etc., which might be damaged by a pressure test. Open all service valves in systems and charge system with refrigerant in accordance with the manufacturer’s written requirement. Add sufficient dry nitrogen to raise system to pressures on suction, discharge and liquid sides of system as indicated below (or higher if required by local code). Check all joints and connections for leaks with a halide torch or electronic leak detector. If leaks are found, all leaks shall be repaired and system retested.

C. After system is proven to be completely free of leaks, the entire system shall be dehydrated by evacuating with vacuum pump. System compressors shall not be used as a vacuum pump. Pull system down to 100 microns and hold for 8 hours. Break vacuum with dry nitrogen. Repeat procedure three times with vacuum being broken the last time with refrigerant. Charge system with refrigerant and check the equipment in accordance with manufacturer's recommendations.

D. DO NOT DISCHARGE ANY REFRIGERANT TO THE ATMOSPHERE.

E. Test Pressure Requirements
1. Line Test Pressure for Refrigerant R-410A:

3.4 Troubleshoot all components of the refrigerant system, both new and existing, when the refrigeration system is started up until the system is operating satisfactorily.

END OF SECTION 230150
SECTION 23 02 00 – MECHANICAL INSULATION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish all labor, services, material and related items necessary to complete the thermal insulation work indicated on the drawings and/or specified herein.

1. Mechanical Piping.
3. Ductwork.

1.2 WORK EXCLUDED

A. Work not included in this Section that is specified in other Sections of these specifications:

1. Insulation saddles for the piping system - Section 230110.
2. Plumbing systems piping insulation - Section 220400.
3. Duct liner - Section 230900.

1.3 RELATED DOCUMENTS

A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.
B. Section 230000 - Mechanical General Conditions.
C. Section 230100 - Installation of Mechanical Piping.
D. Section 220400 - Plumbing Systems (plumbing piping insulation).
E. Section 230900 - Air Distribution.

1.4 QUALITY ASSURANCE

A. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastic and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each mechanical system requiring insulation.

B. Submit product data under provisions of Section 230000. Indicate application for each product.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.
8. Detail field application for each equipment type.

1.6 DELIVERY, STORAGE, AND, HANDLING

A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.
B. Store insulation in a clean, dry place and protect against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site.

1.7 REFERENCES


PART 2 - PRODUCTS

2.1 The piping insulation material for each Type is specified to establish the desired quality and performance. Equal products, complying with the requirements of these specifications, by the following manufacturers are acceptable:

A. Owens-Corning
B. Certain-Teed
C. Armstrong
D. Manson formerly Manville
E. Knauf
F. Rubbatex
G. Imcoa
H. Foamglas

2.2 Type (1) - Owens-Corning Fiberglass, Fiberglass 25 with ASJ all service jacket, seal down lap joints, vapor barrier in jacket. Thermal conductivity of 0.26 BTU/HR/SF°F/IN @ 100°F mean temperature, 0.3 @ 200°F, 0.35 @ 300°F. PVC jacket over fittings. Aluminum jacket over straight sections of piping located outdoors.

2.3 Type (2) - Armattuff Plus II (Flame/Smoke Rating less than 25/50 thru 1" thickness per ASTM E-84) Armaflex foamed plastic flexible sheeting laminated with a white thermoplastic rubber membrane (TPR). TPR membrane shall be UV resistant with a 25 year warranty. Thermal conductivity of 0.28 BTU/HR/SF°F/IN @ 90°F mean temperature.

2.4 Type (3) - Armacell AP/Unslit (Flame/Smoke Rating less than 25/50 thru 1" thickness per ASTM E-84) Armaflex foamed plastic flexible tubing insulation Unslit. Thermal conductivity of 0.28 BTU/HR/SF°F/IN @ 90°F mean temperature. See Execution for allowable locations of Lap Seal.

A. Provide Armafix insulated pipe hangers at all pipe hangers.
2.5 Type (4) - Owens Corning type 703-FRK-25, 3 pound per cubic foot density, rigid insulation. Temperature range -60°F to 450°F. "K" value (BTU/HR/FT²/IN/F) of 0.28 at 75 degrees F and 0.30 at 100 degrees F. Factory applied vapor barrier. Odor free and resistant to growth of bacteria or fungus.

2.6 Type (5) - Owens Corning type 705-FRK-25, 6 pound per cubic foot density, rigid insulation. Temperature range -60°F to 450°F. "K" value (BTU/HR/FT²/IN/F) of 0.28 at 75 degrees F and 0.30 at 100 degrees F. Factory applied vapor barrier. Odor free and resistant to growth of bacteria or fungus.

2.7 Type (6) - Owens Corning All-Service Duct Wrap, 1.5 pound per cubic foot density, blanket type insulation with all service facing with a 2" min. stapling and taping flange on one edge. Temperature range -60°F to 250°F. Factory applied reinforced Foil-Kraft (FRK) vapor barrier. Odor free and resistant to growth of bacteria or fungus. Installed thicknesses and R-Values as indicated below. (* hr-ft²-°F/Btu at 75°F mean temperature.) & (** Assumes 25% compression of insulation.)

<table>
<thead>
<tr>
<th>Nominal Thickness, in.</th>
<th>Density, pcf</th>
<th>Out-of-Package R-Value*</th>
<th>Installed Thickness, in.</th>
<th>Installed R-Value*</th>
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<tr>
<td>1 ½</td>
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<tr>
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<td>1.0</td>
<td>5.6</td>
<td>1 1/8</td>
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<tr>
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<tr>
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<td>1 ½</td>
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<tr>
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<tr>
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<tr>
<td>3</td>
<td>0.75</td>
<td>10.2</td>
<td>2 1/4</td>
<td>8.4</td>
</tr>
</tbody>
</table>

2.8 Type (7) - Hydrous calcium silicate; ANSI/ASTM C533; rigid white; asbestos free; 'k' value of 0.44 at 300 degrees F, 15 pcf maximum dry density, 60 psi minimum compressive strength at 5 percent deformation. Aluminum jacket over straight sections of piping and fiberglass cloth jacket over fittings.

2.9 Type (9) - Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2, felt or glass-fiber mat faced on both major surfaces; maximum board size 48 inches by 96 inches; not less than 2 lbs/cu. ft. density per ASTM D 1622; not less than 20 psi compressive strength; factory-tapered insulation boards fabricated to slopes indicated. Flame Spread: Not greater than 50; ASTM E 84. Smoke Developed: Not greater than 170; ASTM E 84. Tapered Board Insulation: Fabricated to slope of 1/4 inch per 12 inches (1:48) or 1/2 inch per 12 inches (1:24) as noted on the details unless otherwise indicated.

A. Insulation Fasteners: Factory-coated steel fasteners and metal plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening insulation and cover boards to substrates, acceptable to membrane manufacturer.
2.10 Type (10) - Armaflex W (Flame/Smoke Rating 25/50 thru 1" thickness) Armaflex white foamed plastic flexible tubing insulation, unslit. Thermal conductivity of 0.28 BTU/HR/ SF°F /IN @ 90°F mean temperature. Available ½" thick thru 2-5/8" ID and 3/4" or 1" thick thru 4-1/8" ID.

2.11 Type (11) - Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

A. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive 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."
3. Acceptable manufacturers:

B. Cellular-Glass Joint Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F.
   a. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   b. Sealants 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."
5. Acceptable Manufacturers:
   b. Eagle Bridges - Marathon Industries; 405.
   d. Mon-Eco Industries, Inc.; 44-05.
   e. Pittsburgh Corning Corporation; Pittseal 444.

2.12 Type (12) - Armaflex AP White Unslit (Flame/Smoke Rating 25/50 thru 1" thickness) Armaflex white foamed plastic flexible tubing insulation, Unslit. UV resistant thermal conductivity of
0.28 BTU/HR/SF°F /IN @ 90°F mean temperature. Available ½" thick thru 2-5/8" ID and 3/4" or 1" thick thru 4-1/8" ID. See Execution for allowable locations of Lap Seal.

A. Provide Armafix insulated pipe hangers at all pipe hangers.

2.13 JACkETS

A. Vapor Barrier Jackets: Kraft reinforced foil vapor barrier with self-sealing adhesive joints.

B. PVC Jackets: One piece, premolded type.

C. Aluminum Jackets: ASTM B209; 0.032 inch thick; Stucco Embossed corrugated finish; 2-1/2" deep corrugations. Childers jacketing system, ITW Insulation system, or equal.
   1. Finish and thickness are indicated in field-applied jacket schedules.
   2. Moisture Barrier for Indoor Applications: 1-mil thick, heat-bonded polyethylene and kraft paper or 2.5-mil thick polysurlyn.
   3. Moisture Barrier for Outdoor Applications: 2.5-mil thick polysurlyn.

D. Vapor barrier mastic coatings:
   1. for outdoor service: Foster Division - 30-15
   2. for indoor service: Foster Division - 30-80 or 30-90 (water based)
   3. Or equal products by the following manufacturers:
      a. Exxon Chemical Company USA
      b. Insul - Coustic IC
      c. Epolux-Cadalar

E. Reinforced Polyvinyl-Chloride (PVC) Flashing Sheet: ASTM D 4434, Type III, fabric reinforced and fabric scrim-backed; felt backed; capable of being heat-welded. Sheet Thickness: 60 mils, nominal. (For use on ductwork exterior location where indicated on the plans.)

F. Thermoplastic Polyolefin (TPO) Flashing Sheet: ASTM D 6878, internally fabric or scrim reinforced, uniform, flexible TPO sheet; free of surface defects and embossing or marking which affect membrane thickness or performance; capable of being heat-welded. Thickness: 60 mils, nominal. (For use on ductwork exterior location where indicated on the plans.)

G. Removable/Reusable Valve Covers - select one of the following:
   1. Cover shall be factory fabricated of 1" close cell elastomeric insulation (Flame/Smoke rating less than 25/50 per ASTM E-84) with Velcro closures. Thermal conductivity of 0.28 BTU/HR/SF°F /IN @ 90°F mean temperature. Cover shall overlap adjoining sections of pipe insulation and shall totally enclose all portions of the valve being covered. Installation shall not require the use of any special hand tools. As manufactured by Corick, Baton Rouge, Louisiana, or approved equal.

   2. Cover shall be factory fabricated of 1-½" fiberglass blanket insulation. Thermal conductivity of 0.26 BTU/HR/SF°F/IN @ 100°F mean. Flame/Smoke rating less than 25/50 per ASTM E-84. Outer jacket shall be made of material equal to DuPont Tychem® QC, overlapping and completely covering the insulation with seams joined with Velcro
closures. Butt ends shall have sewn-in-place elastic. Outer jacket shall overlap adjoining sections of pipe insulation and shall totally enclose all portions of the valve being covered. Installation shall not require the use of any special hand tools. As manufactured by “No Sweat” Valve Wraps, Inc., Fit Tight Covers, or approved equal.

3. Cover shall be factory fabricated with molded polyisocyanurate insulation or molded cellular glass insulation. Polyisocyanurate shall comply with ASTM C591, nominal 2 lb/ft3 density, K factor of 0.19 Btu/hr/ft2F at 75°F mean temperature. Cellular glass shall comply with ASTM C 552, Type III and shall be inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Covers shall comply with Flame/Smoke Rating less than 25/50 per ASTM E-84. Covers shall have close fitting PVC or aluminum jackets. Units shall have plugs that allow valve to be operated without removing the cover. Outer jacket shall have seams joined with Velcro closures, shall overlap adjoining sections of pipe insulation, and shall totally enclose all portions of the valve being covered. Installation shall not require the use of any special hand tools. As manufactured by Extol of Ohio, or approved equal.

H. Underground Direct-Buried Jacket: 125-mil-thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
   1. Acceptable Products and Manufacturers:
      a. Pittsburgh Corning Corporation; Pittwrap.
      b. Polyguard; Insulrap No Torch 125.

I. PVC Insulation Fitting Covers:
   1. Factory fabricated, pre-molded, fitting covers manufactured from 20-mil-thick, high-impact, ultraviolet-resistant PVC.
   2. Factory fabricated, pre-molded, fiberglass fitting inserts, 1-1/2 pound per cubic foot density, semi-rigid insulation formed to fit the pipe fitting, valve, etc. that it is designed to cover.
   3. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, traps, and mechanical joints.
   4. Acceptable manufacturers:
      a. Ceel-Co, “Ceel-tite #320” (indoors), #330 (outdoors 0°F to 150°F)
      b. Certain Teed, “Snap Form”
      c. Foster Div., H.B. Fuller Co., “Speedline Smoke-Safe”
      d. Knauf, “Proto Lo SMOKE”
      e. Manville, “Zeston 2000”
   5. Adhesive: Compatible with fitting cover material. Do not use regular PVC cement.
      a. Acceptable manufacturers:
         1) Ceel-Co, “Ceel-tite #300” Solvent Welding Adhesive
         2) Knauf, “Proto Solvent Adhesive”
         3) Manville, “Perma-Weld Adhesive”
4) Aluminum fitting covers by GASCO are equally acceptable.

2.14 ACCESSORIES

A. Insulation Bands: ¾ inch wide; 0.015 inch thick galvanized steel.
B. Metal Jacket Bands: ¼ inch wide; 0.015 inch thick aluminum.
D. Finishing Cement: ASTM C449.
E. Fibrous Glass Cloth: Untreated; 9 oz/sq yd weight.
F. Adhesives/Tapes: Compatible with insulation.
G. Flexible elastomeric foam finish-Armstrong FR/Armaflex finish.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING INSULATION

A. Install insulation, vapor retarder and jacketing per manufacturer’s recommendations. Particular attention should be paid to recommendations for joint staggering, adhesive application, external hanger design, expansion/contraction joint design and spacing and vapor retarder integrity.

B. Insulate all pipe, valves, and specialties except where insulation is specifically indicated to be omitted.

C. All insulation shall be continuous through wall, floor, and ceiling openings and sleeves.

D. Install insulation with all joints tightly butted (except expansion joints in hot applications).

E. Piping insulation and jacketing shall be applied in accordance with MICA (Midwest Insulation Contractors Association) Plate #3 (b) requirements. Insulation at hangers shall be applied in accordance with MICA Plate #6A. Insulation for fittings, valves, flanges, and couplings shall be installed in accordance with MICA Plates 10-18.

F. The open end of all insulation shall be neatly beveled either by beveling the insulation or by using finish cement.

G. Prior to application of insulation, heat tracing, or painting; piping and equipment shall have been tested and accepted.

H. All surfaces to be insulated shall be clean and dry. Special solvents are not required for use in cleaning, but any oil, grease, dirt or foreign material shall be wiped or scraped from the pipe or equipment surface. Insulation shall not be applied on damp or frosty surfaces.

I. All pipe lines with hangers, saddles, etc., shall be set in their permanent location before insulation is applied. Should it be necessary to block or shore up pipe to install insulation, or should it be necessary to displace or remove hangers, the pipe and hangers shall be restored to their original location and alignment when the insulation is complete. Where pipe hangers are installed in a manner that prevents the specified insulation thickness to be installed, the pipe hangers shall be adjusted or moved and rehung to allow the specified insulation thickness to be applied.
J. Where insulated piping is supported by hangers clamped directly to the pipe, the insulation shall be carefully fitted around hanger clamp and sealed at openings in jacket.

K. For all cold service piping:
   1. Seal the beginning and end of each run of insulation to the pipe being insulated with vapor barrier mastic to prevent air from entering the space between the pipe and the insulation. This especially applies at connections to air handling units and similar equipment. See details on plans.
   2. Install a vapor stop on each side of all valves that are not fully encapsulated by the insulation including all valves where the stem or handle protrudes outside the insulation. The vapor stop shall consist a vapor barrier and mastic to prevent moisture from traveling longitudinally along the insulation in the space between the pipe and the insulation. See details on plans.
   3. Vapor retarder/seal shall be installed in a continuous manner. No staples, rivets, screws or any other attachment device capable of penetrating the vapor retarder/seal shall be used to attach the vapor retarder/seal or jacketing. No wire ties capable of penetrating the vapor retarder/seal shall be used to hold the insulation in place. Banding shall be used to attach PVC or metal jacketing.
   4. Where cold service piping attaches to coils in air handling equipment, vapor seal the end of the insulation and seal insulation to air handling unit casing. Seal in accordance with air handling unit manufacturer’s installation instructions or as directed by the Engineer.
   5. At pipe riser supports, where the support is clamped directly to the pipe, insulation shall be installed over the outside of the riser support clamp and shall totally enclose the riser clamp.

L. Insulate heating and cooling coil headers located outside of units or ductwork or not located above a condensate pan as specified for piping.

M. Unions, flanges and valves:
   1. All unions, flanges, valves and other similar fittings shall be insulated unless otherwise indicated.
   2. Extended Stems: Where insulation is indicated or specified, coordinate with contractor furnishing valves to furnish extended stems arranged to receive insulation. Cold service valves that are insulated with removable covers do not require extended stems.
   3. For all cold service piping:
      a. Insulate all balance (flow control) valves, flow measuring devices, and stop valves (except valves located in mechanical rooms and valves exterior to the building) with molded, pre-shaped fiberglass insulation inserts and cover with a two piece PVC Fitting Cover. Insulation and fitting cover shall be removable. Secure the two piece PVC fitting cover by taping the ends to the adjacent pipe covering. All seams of cover shall be sealed with vapor barrier pressure sensitive color matched tape.
      b. Insulate all balance (flow control) valves, flow measuring devices, and stop valves (except valves located in mechanical rooms and valves exterior to the building) with factory fabricated removable/reusable valve covers. Install in accordance
with the manufacturers instructions to prevent the condensation. All removable valve covers shall be the same manufacture.

c. Insulate all fittings, control valves, manual valves (in mechanical rooms and valves exterior to the building), check valves, unions, instruments, hanger rods and clamps, and flanges with molded, pre-shaped insulation inserts of the same material as the straight pipe insulation, or wrap the fitting, valve, etc. with 1.5-pound density flexible fiberglass insulation to a thickness equal to the adjacent piping insulation, and cover with a one piece PVC Fitting Cover per MICA Plate 17A or 18. Tuck the ends of the insulation snugly into the throat of the fitting and the edge adjacent to the pipe fitting. Secure the one piece PVC fitting cover by taping the ends to the adjacent pipe covering. All seam edges of cover shall be sealed with vapor barrier pressure sensitive color matched tape. The tape shall extend over the adjacent pipe insulation and have an overlap on itself at least 2 inches. Use of polyurethane spray-foam to fill PVC elbow jacket is prohibited on cold applications.

N. At pipe hangers, furnish and install a sheet metal protection shield and wooden inserts the same thickness as the insulation. Shields and blocks are intended to prevent the crushing of the insulation. Blocks shall be sealed to provide continuity of the vapor barrier.

1. In lieu of the wooden blocks at pipe hangers, this Contractor may, at his option, provide rigid insulation saddle, equal to Fee and Mason Fig. 71, consisting of rigid urethane foam insulation with vapor barrier jacket. Thermal conductivity of 0.13 BTU/HR/FT2/°F/IN @ 75°F. Insulation lengths shall be three (3) times the pipe diameter plus 8" with a minimum length of 20". Insulation thickness shall be the same as the pipe insulation.

O. Exterior Applications

1. Type 1, 7 or 8: Cover with aluminum jacket with seams located on bottom side of horizontal piping. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement.

2. Type 2, 3 or 12: Coat with flexible elastomeric foam finish per manufacturer’s instructions.

3.2 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.

4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
5. Only where Unslit Insulation cannot be installed and longitudinal slit is needed, provide Lap Seal insulation. The longitudinal slit should only be used when insulating existing piping.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
   2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of cellular-glass insulation to valve body.
   2. Arrange cellular glass insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.

3.3 INSTALLATION OF EQUIPMENT INSULATION

A. Install equipment insulation products in accordance with manufacturer's written instructions, and in compliance with recognized industry practices to ensure that insulation serves intended purpose.

B. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gapping joints and excessive voids resulting from poor workmanship.

C. Maintain integrity of vapor-barrier on equipment insulation and protect it to prevent puncture and other damage.

D. Do not apply insulation to equipment while the equipment surface temperature is above or below ambient air temperature.

E. Apply insulation using staggered joint method for both single and double layer construction, where feasible. Apply each layer of insulation separately.

F. Coat insulated surfaces with layer of insulating cement, troweled in workmanlike manner, leaving smooth continuous surface. Fill in scored block, seams, chipped edges and
depressions, and cover over wire netting and joints with cement of sufficient thickness to remove surface irregularities.

G. Cover insulated surfaces with all-service jacketing neatly fitted and firmly secured. Lap seams at least 2”. Apply over vapor barrier where applicable.

H. Provide removable insulation sections to cover parts of equipment which must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames and accessories.

I. Attachments beyond the insulation line on equipment such as stiffening rings shall be considered an integral part of the equipment and shall be insulated and finished in the same manner as the equipment proper. Thickness of insulation on such attachments and projections shall be the same as the adjoining insulation.

J. Equipment exposed to Weather: Protect outdoor insulation from weather by installation of mastic or weather-barrier protective finish, or jacketing, as recommended by manufacturer.

3.4 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. Ducts and Plenums, Exposed

   1. None.

C. Piping, Exposed or Concealed:

   1. None.

D. If more than one material is listed, selection from materials listed is Contractor’s option.

3.5 INSULATION THICKNESS

A. The following equipment requires field applied insulation:

   1. The following piping requires field applied insulation:

      | System                                         | Insulation Type | Thickness |
      |-----------------------------------------------|-----------------|-----------|
      | Condensate Drain Lines (Inside Building)       | 3               | 1/2”      |
      | All VRF refrigerant piping (interior)          | 3               | 3/4”      |
      | All VRF refrigerant piping (exterior or attic) | 12              | 1”        |

   2. The following ductwork requires field applied insulation:

<pre><code>  | System                                         | Insulation Type | Thickness |
  |-----------------------------------------------|-----------------|-----------|
  | Supply plenum boxes attached to Slot grilles where not located | 6               | 1-1/2”    |
</code></pre>
<table>
<thead>
<tr>
<th>Description</th>
<th>B</th>
<th>Thickness</th>
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<tr>
<td>within a return plenum</td>
<td>6</td>
<td>1-1/2”</td>
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<tr>
<td>Round supply air ductwork above ceilings, in chases, and other concealed</td>
<td>6</td>
<td>1-1/2”</td>
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<td>locations</td>
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<tr>
<td>Round Return air ductwork above ceilings, in chases, and other concealed</td>
<td>6</td>
<td>1-1/2”</td>
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<td>locations</td>
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<tr>
<td>Round Outside Air ductwork above ceilings, in chases, and other concealed</td>
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<td>2”</td>
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<tr>
<td>locations</td>
<td></td>
<td></td>
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<tr>
<td>Round supply air ductwork from energy recovery units unless lined</td>
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<td>1-1/2”</td>
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<td>Rectangular Outside Air ductwork</td>
<td>4</td>
<td>2”</td>
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<tr>
<td>Rectangular or Round Outside Air Intake ductwork</td>
<td></td>
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<tr>
<td>- above ceilings, in chases, and other concealed locations</td>
<td></td>
<td></td>
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<tr>
<td>- in Equipment rooms</td>
<td></td>
<td></td>
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<tr>
<td>Gas Fired Equipment Rectangular or Round Outside Air Intake ductwork</td>
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<td>2”</td>
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<tr>
<td>6 (round only)</td>
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END OF SECTION 230200
**SECTION 23 06 05 – ENERGY RECOVERY UNITS**

**PART 1 - GENERAL**

1.1 DESCRIPTION OF WORK

A. Furnish all labor, material, services and related items necessary to complete the energy recovery unit installation shown on the plans and as specified herein.

1.2 RELATED DOCUMENTS

A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.

B. Section 230000 - Mechanical General Conditions.

C. Section 230010 - Basic Mechanical Materials and Methods.

D. Section 230900 - Air Distribution.

E. Section 230961 - Temperature Control Wiring.

F. ANSI/NFPA 70 National Electrical Code.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of packaged energy recovery units of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Each unit shall be furnished complete with specified components and accessories as required.

C. All units shall have energy transfer ratings certified in accordance with ARI Standard 1060, and shall bear the ARI seal.

D. Units, and all accessories, shall be listed by Underwriter's Laboratories, Inc. or Engineering Testing Laboratories and bear the appropriate U.L. or ETL label.

E. Where indicated on the plans, units shall have a maximum cross contamination from the exhaust air stream to the make-up air stream of 1.0%. If needed to meet this criteria, unit shall be furnished with a purge section on the wheel.

1.4 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 230000.

B. Product data shall indicate typical catalog of information including optional components and arrangement, unit size, capacities at scheduled conditions, ratings, fan performance, motor electrical characteristics, and gages and finishes of materials.

C. Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

D. Submit manufacturer's installation instructions.
E. Submit operation and maintenance data under provisions of Section 230000 including start-up instructions, instructions for lubrication, maintenance data, parts lists, controls, and accessories. Include trouble-shooting guide.

1.5 REFERENCES
A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only. Latest edition shall apply unless otherwise indicated.
B. ASTM A 525 - General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
C. ASTM A 527 - Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality.
E. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
F. ANSI/AMCA Standard 204-05 - "Balance Quality and Vibration Levels for Fans".
G. ANSI/AHRI Standard 260-12 - "Sound Rating of Ducted Air Moving and Conditioning Equipment".

1.6 STORAGE AND HANDLING
A. Hoist energy recovery units to the location where they will be installed.
B. Handle energy recovery units and components carefully to prevent damage, breakage, denting and scoring. Do not install damaged energy recovery units or components; replace with new. Comply with manufacturer's rigging and installation instructions for unloading energy recovery units, and transporting them to final location.
C. Store in a clean, dry place and protect units from damage by weather, dirt, fumes, construction debris, water, and physical damage.

PART 2 - PRODUCTS
2.1 GENERAL
A. Construct energy recovery units for exterior interior installation as indicated. Units shall have supply and exhaust fans, filters for outside air and exhaust air ahead of the energy wheel, an enthalpy recovery wheel to transfer both sensible and latent heat between the outside air and exhaust air streams, a single point power connection, motorized dampers on both the outside air intake and the exhaust air outlet, and defrost controls.
B. Manufacturer shall provide all other components required to provide a complete installation.
C. Energy recovery unit shall include casing, structural frame, centrifugal fans, V-belt drives and hi-efficiency motors.
2. All materials shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less when tested in accordance with NFPA Standard 84.

2.2 MANUFACTURERS

A. Energy recovery unit selection has been based on the manufacturer scheduled to establish the desired quality, style and type. Equal products, complying with these specifications by the following manufacturers are acceptable:

1. Semco
2. American Aldes (Venmar)
3. Aaon
4. Carnes
5. Governaire
6. Greenheck
7. Valent

B. All energy recovery units shall be by one manufacturer.

2.3 UNIT CABINET: UNITS 3,500 CFM OR LESS

A. Cabinet shall be constructed of reinforced galvanized steel with minimum 14 gauge frame and minimum 20 gauge skin enclosing minimum 1.0 inch thick, foil faced fiberglass insulation with minimum "R" value (FT^2°F/BTU/HR) of 3.5. Unit shall have knockouts for electrical and piping connections, exterior drain connection, and lifting lugs. Unit shall have removable panels for access to the heat wheel. Cabinet shall be finished with either galvanizing or factory-applied corrosion resistant paint. Provide 1/4 turn fasteners at access doors. Cabinet work shall be reinforced and gasketed with neoprene gaskets to withstand the fan close-off static pressure at operating speed. Cabinets shall be suitable for draw-thru arrangement. All metal-to-metal seams shall be sealed, requiring no caulking at job site. Units for outdoor installation shall have top panels joined with a standing seam to insure positive weather protection.

B. Sheet metal shall be mill-galvanized (two-sided) carbon steel and shall conform to ASTM A525 coating class G-90, lock forming quality.

2.4 HEAT EXCHANGER

A. Enthalpy Heat Exchanger Core

1. The heat exchanger element shall consist of a specially processed, nonflammable, HEP (high efficiency paper) heat exchanger designed to allow the exchange of both sensible and latent energy between the supply and exhaust airstreams. The core material shall be tested as specified in UL 723 and have a flame spread rating of not more than 25, and a smoke developed rating of not more than 50.

2.5 FANS

A. General
1. Provide fans that are factory fabricated and assembled, factory tested, and factory finished, with indicated capacities and characteristics. Balance fans in accordance with AMCA 204-05.

2. Fans up to 3,500 cfm shall be DWDI, centrifugal type.

B. Fans and Shafts: Statically and dynamically balance and designed for continuous operation at the maximum rated fan speed and motor horsepower. Fan shaft shall be turned, ground, and polished steel, designed to operate at no more than 70 percent of the first critical speed at the top of the speed range of the fan's class.

C. Belt-Driven Drive assembly: Resiliently mounted to the housing with the following features:

1. Motor Pulleys: Cast-iron. Adjustable pitch for use with motors through 15 HP; fixed pitch for use with motors larger than 15 HP. Select pulley so that pitch adjustment is at the middle of the adjustment range at fan design conditions. When fixed pitch sheaves are furnished, a replaceable sheave shall be provided when needed to achieve system air balance.

2. Fan Wheel Pulleys: Cast-iron, fixed pitch.

3. Dynamically balanced, bored to fit shafts and keyed.


5. Belts: Oil-resistant, non-sparking, and non-static.

D. Motor and Fan Wheel Pulleys: Adjustable pitch for use with motors.

E. Fan Wheels: Hub keyed to the shaft.

1. Blade Materials: Steel or aluminum.

F. Shaft Bearings: Prelubricated and sealed, self-aligning, ball bearings.

G. Accessories: The following accessories shall be provided:

1. Adjustable motor slide base.

H. Isolators:

1. Fans 3,500 cfm or less shall be isolated within the unit on rubber in shear isolators that are seismically restrained. Isolators shall have 0.75" static deflection and be equal to Model RBA by Mason Industries.

2.6 MOTORS AND DRIVES

A. Motors shall have open, drip proof enclosures and shall have a service factor not less than 1.15. Motors shall be in accordance with Section 230050. Motors shall have electrical characteristics as indicated on the schedule on the plans.

2.7 ACCESS DOORS AND PANELS

A. Access doors shall be of 20-gage construction and shall provide access from two sides minimum.
2.8 FILTERS

A. Provide flat filter frames for bottom or side servicing with necessary gasketing to seal between filter and frame and spring type hold down clips to secure filters in place. Air filter shall be 35% efficiency. Filters shall be changeable without the need of tools, nuts or bolts. Size for standard 24” x 24” x 2” filter media. Provide filters for both supply and exhaust airstreams.

B. Provide 2 inch thick Farr 30-30 filters or equal.

2.9 DAMPERS

A. Outside air/exhaust air dampers.

1. The dampers shall be equivalent to Ruskin series CD60 low leakage opposed blade control dampers or approved equal.
2. Frame shall be 16 gauge galvanized steel. Blades shall be 14 gauge equivalent thickness, maximum 6” wide. Seals shall be extruded vinyl blade edge seals and flexible metal compressible jamb seals. Bearings shall be stainless steel sleeve. Axles shall be ½” plated steel hex. Provide mill galvanized finish.
3. Maximum Leakage at 1” water gauge differential pressure and when tested in accordance with AMCA Standard 500 shall not exceed 4 CFM per sq. ft.
4. Maximum single dampers section shall be 60” wide x 72” high. For multiple section dampers, each section shall be operated by a separate actuator.
5. The actuators shall be two position, spring return, normally closed for fail-safe operation, and shall be interlocked to open when the unit is energized. Actuators shall be Belimo or approved equal.
6. The actuator shall have built in overload protection to prevent damage to the actuator when the actuator or damper reaches its end position. The actuator shall be UL listed. Actuator on the fresh air inlet damper shall be provided with auxiliary end switch for fan interlock to be provided under Section 230960.

B. Back draft dampers shall comply with the following:

1. Back draft dampers shall be equivalent to Ruskin model BD-6.
2. Shall have minimum 2”, 0.125” thick extruded aluminum frame reinforced for rigidity.
3. Aluminum blades of maximum 6” width.
4. Adjustable counterweight.
5. Cadmium plated steel shafts.
7. Hardware shall be cadmium plated steel with brass pins.
8. Dampers shall include blade edge seals. Leakage shall be less than 12 cfm per sq. ft. at 1/2 inch W.G.

2.10 ELECTRICAL

A. Unit shall have a single connection for the voltage shown on the equipment schedule. Include all starters, transformers, integral door interlock disconnecting device, etc. Include a non-fused disconnect switch at the single point of connection.
B. Electrical components shall be NEMA 1 enclosures for equipment located indoors and NEMA 3R enclosures for enclosures exposed to the weather.

C. Starters shall be magnetic type for the motor voltage indicated. In each magnetic starter provide:
   1. Cover-mounted "Start" button, cover-mounted "Hand-Off-Automatic" selector switch or "Start-Stop" pushbutton, and manual overload reset button.
   3. Three overload relays properly sized for the actual motor nameplate current and motor operating conditions.
   4. Auxiliary contacts required for sequence of operation.
   5. Control transformer (unless otherwise indicated) for maximum control voltage of 120 VAC complete with primary and secondary overcurrent and short circuit protection.

2.11 MAGNETIC CONTROLLERS

A. Full voltage, across the line, electrically held, for supply and return fans.

   1. Configuration: Nonreversing.
   2. Contactor Coils: Pressure-encapsulated type
   3. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
   4. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses.
   5. Solid-State Overload Relay:
      a. Switch or dial selectable for motor running overload protection.
      b. Sensors in each phase.
      c. Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
      d. Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
      e. Analog communication module.
   6. N.O. isolated overload alarm contact.
   7. External overload reset push button.

2.12 CONTROLS

A. Unit shall be provided with a factory mounted and wired microprocessor control operating on 115 volts or less.

B. Unit shall have contacts for placing unit in Occupied/Unoccupied operation from a building management time clock.

C. Occupied contacts shall start the ERU unit. Wiring in the control panel shall start the exhaust fan, the supply fan, and the energy recovery wheel, after the outside and exhaust dampers are open. Both the supply fan and the exhaust fan shall operate continuously during occupied time periods.
D. Unit shall have defrost controls to prevent ice from forming in the unit by stopping the exhaust fan, closing the outdoor damper and circulating return air through both sides of the wheel. Recirculation shall only be required when the outdoor temperature is below 5°F and shall operate no more than 15% of the time.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances, support structure, and other conditions affecting performance of energy recovery units.

B. Examine rough-in for electrical to verify actual locations of connections prior to installation.

C. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install units level and plumb, in accordance with manufacturer's written instructions. Support units as described below, using the vibration control devices indicated. Vibration control devices are specified in Section 230020 "Vibration Controls."

1. Suspended Units: Units shall be suspended from structure using threaded steel rods, double nuts, and vibration isolators indicated in Section 230020.

B. Arrange installation of units to provide access space around units for service and maintenance.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 sections. The Drawings indicate the general arrangement of piping, valves, fittings, and specialties. The following are specific connection requirements:

1. Arrange piping installations adjacent to units to allow for unit servicing and maintenance.
2. Connect piping to units.
3. Connect condensate drain pans using 1¼ inch copper tubing, unless otherwise indicated. Extend to the nearest equipment or floor drain. Construct trap at connection to drain pan to provide a water seal correlated to the fan TSP and install cleanouts at changes in direction. Install trap per details on the plans and the manufacturer's instructions.

B. Duct installations and connections are specified in Section 230900. Make final duct connections with flexible connections.

C. Electrical Connections: The following requirements apply:

1. Electrical power wiring is specified in Division 26.
2. Temperature control wiring and interlock wiring is specified in Section 230950 or 230961, Temperature Control Wiring.
3. Grounding: Connect unit components to ground in accordance with the National Electrical Code.
3.4 Adjust damper linkages for proper damper operation.

3.5 Clean unit interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheel and cabinet before start-up and before placing unit in operation.

A. Demonstration Services: A contractor’s representative shall train Owner’s maintenance personnel on the following:

1. Procedures and schedules related to start-up and shut down, troubleshooting, servicing, preventative maintenance, and procurement of replacement parts. A copy of training documentation shall be provided.
2. Schedule training with Owner, provide at least 7 days’ advance notice.

B. Provide new filters before air balance and before substantial completion.

3.6 Refer to Sections 230910, "Start-up, Cleaning and Testing", 230930 "Balancing" and 230950 or 230961 "Temperature Control Wiring" for procedures for air-handling-system testing, adjusting, and balancing.

3.7 COMMISSIONING

A. Perform the following operations and checks before start-up:

1. Remove shipping, blocking, and bracing.
2. Verify unit is secure on mountings and supporting devices and those connections for piping, ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starter, and disconnects.
3. Disconnect fan drive from motor, verify proper motor rotation direction, and verify free fan wheel rotation and smooth bearing operation. Reconnect fan drive system, align belts, and install belt guards.
4. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
5. Adjust or replace fan and motor pulleys as required to achieve design conditions.
6. Measure and record motor electrical values for voltage and amperage.
7. Verify fans and wheel start/stop in response to the Occupied/ Unoccupied signal. Verify that the wheel operates at full speed above 55°F and varies the speed of the wheel below 55°F to maintain a maximum discharge temperature of 55°F.

END OF SECTION 230605
PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish all labor, services, material and related items necessary to complete the exhaust fan installation indicated on the drawings and/or specified herein.

1.2 RELATED DOCUMENTS

A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.

B. Section 230000 - Mechanical General Conditions.

C. Section 230010 - Basic Mechanical Materials and Methods.

D. Section 230020 - Vibration Isolation and Seismic Restraints.

1.3 PERFORMANCE REQUIREMENTS

A. Operating Limits: Classify according to AMCA 99.

B. Vibration Levels: Comply with ANSI/AMCA Standard 204-05, "Balance Quality and Vibration Levels for Fans".

C. Fan Unit Schedule: The following information is described in an equipment schedule on the Drawings.

1. Fan performance data including capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

2. Fan arrangement including wheel configuration, inlet and discharge configurations, and required accessories.

1.4 QUALITY CONTROL

A. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings in accordance with AMCA Standard 210 - Laboratory Methods of Testing Fans for Rating.

B. Sound Power Level Ratings:

1. Comply with AMCA Standard 301 "Method for Calculating Fan Sound Ratings From Laboratory Test Data."

2. Test fans in accordance with AMCA Standard 300 "Test Code for Sound Rating."

3. Fans shall be licensed to bear the AMCA Certified Sound Ratings Seal.

C. UL Compliance:

1. Fans and components shall be UL listed and labeled.
2. Fans shall be designed, manufactured, and tested in accordance with UL 705 "Power Ventilators".

D. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code".

1.5 SUBMITTALS

A. General: Submit the following in accordance with Section 230000.
   1. Product data for selected models, including accessories.
   2. Shop drawings detailing equipment assemblies and indicating dimensions, weights, required clearance, components, and location and size of field connections.
   4. Roof curb dimensional data and provisions for flashing.
   5. Motor ratings and electrical characteristics plus motor accessories.
   6. Wiring diagrams that detail power and control wiring. Differentiate between manufacturer-installed wiring and field-installed wiring.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

B. Protect units on site from physical damage.

C. Deliver fan units as a factory-assembled unit to the extent allowable by shipping limitations, with protective crating and covering.

PART 2 - PRODUCTS

2.1 FANS, GENERAL

A. General: Provide factory fabricated, assembled, tested, and finished fans with indicated capacities and characteristics.

B. Fans and Shafts: Statically and dynamically balanced and designed for continuous operation at the maximum rated fan speed and motor horsepower.

C. Fan Shaft: Turned, ground, and polished steel, keyed to wheel hub, designed to operate at not more than 70 percent of the first critical speed at the top of the speed range of the fan's class.

D. Guards: For motors mounted on the outside of the fan cabinet. Galvanized steel, expanded metal with reinforced edges on inlet and outlet except not required on outlet if unit is equipped with gravity shutter.

E. Shaft Bearings: Provide Type indicated, having a median life "Rating Life" (AFBMA L10) of 200,000, calculated in accordance with AFBMA Standard 9 for ball bearings and AFBMA Standard 11 for roller bearings.

F. Factory Finish: The following finishes are required for all parts that are not aluminum:
1. Sheet Metal Parts: Prime coating prior to final assembly.
2. Exterior Surfaces: Baked-enamel finish coat after assembly.

G. Motors: Motors shall be in accordance with Section 230050. Minimum sizes and electrical characteristics as indicated. If not indicated, motors shall be large enough so that the driven load will not require the motor to operate in the service factor range.

H. Motor Bases shall be adjustable to allow for adjustment of belt tension.

I. Starters, Electrical Devices, Wiring and connections are specified in Division 26. Disconnect devices are specified below.

J. Fans used shall not decrease motor size, increase noise level, or increase tip speed by more than 10 percent, or increase inlet air velocity by more than 5 percent, from specified criteria.

K. Accessories (where indicated on plans):

1. Thermostat. Line voltage, rated for 8 amps at 120 vac. Normally open contacts close as temperature rises. Honeywell model T651A or equal.
2. Humidistat. Line voltage, rated for 7.5 amps at 120 vac. Normally open contacts close as humidity rises. Honeywell model H46C or equal.
3. Internally mounted fan speed control rated for 15 amps at 120 vac that can reduce the fan to 60% of the rated airflow.

L. Fan selections (except vaneaxial fans) have been based on the manufacturer scheduled to establish the desired type, quality, and performance. Equivalent products by the following manufacturers are acceptable:

1. Greenheck Fan and Ventilator Company
2. Loren Cook Company
3. Penn Ventilator
4. Acme
5. Jenn Air
6. New York Blower
7. Twin City

M. Vaneaxial fan selections have been based on the manufacturer scheduled to establish the desired type, quality, and performance. Equivalent products by the following manufacturers are acceptable:

1. Buffalo Forge Co.
2. Flakt-Woods
3. Howden (Joy Technologies Inc.)

2.2 CEILING MOUNTED AND CABINET FANS

A. General Description: Centrifugal fan designed for installation in ceiling, wall, or concealed inline applications.

B. Housing: Galvanized steel lined with 1/2" acoustic liner.
C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.

D. Fan motor shall be mounted on vibration isolators.

E. Plug-in type disconnect.

F. Aluminum grille with a white enamel finish.

G. U.L. listed.

H. Back draft damper.

2.3 PROPELLER FANS

A. General Description: Belt-driven or direct-drive propeller fans, as indicated, consisting of fan blades, hub, housing, orifice ring, motor, drive, and accessories.

B. Fan Wheel:
   1. Wheels: Formed-steel blades riveted to a heavy-gage steel spider bolted to cast-iron hub.

C. Fans shall be suitable for mounting as shown on the plans.

D. Motor shall be mounted on a heavy gauge steel frame bolted to a heavy gauge steel mounting frame. Mounting frame shall be all welded construction, suitably reinforced for the duty intended.

E. Accessories:
   1. Non-fused disconnect switch, factory mounted and wired.
   2. OSHA approved guard on the inlet side of the fan.
   3. Gravity, as specified below backdraft damper on the discharge side of the fan.
   4. Steel, wall mounting sleeve.

2.4 SIDEWALL EXHAUST FANS

A. General Description: sidewall, centrifugal type, V-belt or direct driven as indicated with spun aluminum housing; resiliently mounted motor; bird screen; secured with cadmium plated bolts and screws.

B. Fan housing shall be removable to allow access to the motor.

C. Fan Wheel: Aluminum hub and wheel with backward inclined blades.
D. Galvanized steel birdscreen, 1/2 inch mesh, 16 gage.

E. Accessories:

1. Gravity backdraft damper as specified below.
2. Non-fused disconnect switch, factory mounted and wired.
3. Steel, wall mounting sleeve.

2.5 BACKDRAFT DAMPERS

A. Backdraft dampers shall comply with the following: (except for Utility Vent Sets)

1. General Description: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base or at discharge of wall fan, factory set to close when fan stops.
2. Blades: extruded aluminum, 0.070" thick with extruded vinyl edge seals.
3. Frame: extruded aluminum, 0.125" wall thickness.
4. Linkage: 1/2" tie bars.
5. Bearings: Synthetic.
6. Temperature Range: -40°F to 200°F.
7. Maximum face velocity: 3500 FPM.
8. Maximum Leakage: 12 CFM per square foot at 1/2" W.G. differential.
9. Dampers shall be Ruskin Model BD6 Heavy Duty Backdraft Dampers or approved equal.

B. Backdraft dampers for Utility Vent Sets shall comply with the following:

1. Shall have a not less than 8"x 2", 10-gauge galvanized steel channel frame.
2. Double skin airfoil galvanized blades of maximum 7" width.
3. Adjustable counterweight.
4. Cadmium plated steel shafts.
5. Blade shafts shall operate in ball bearings.
6. Hardware shall be cadmium plated steel with brass pins.
7. Dampers shall include blade edge seals. Leakage shall be less than 135 cfm per sq. ft. at 1 inch W.G.
8. Back draft dampers shall be Ruskin model CSB-8 or approved equal.

PART 3 - EXECUTION

3.1 Handle Fans carefully to avoid damage to components, enclosures and finish. Do not install damaged components; replace and return damaged components to equipment manufacturer. Store Power Ventilators and Fans in clean dry place and protect from weather and construction traffic.

3.2 Install Fans where indicated, in accordance with equipment manufacturer’s installation instructions and with recognized industry practices, to ensure that equipment complies with requirements and serves intended purposes. Exhaust fan outlets shall be installed a minimum of 10'-0" away from any outside air intakes for HVAC systems (i.e.: intakes on rooftop units, intake caps or goosenecks, intake louvers, etc.) and any operable windows.

3.3 INSTALLATION
A. Suspended Units: Fans shall be suspended from structure using threaded steel rods and vibration isolators. Isolators shall be furnished under Section 230020.

3.4 Install fans with flexible duct connections. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.

3.5 SEISMIC BRACING AND RESTRAINTS

A. Provide seismic bracing and restraints for all power ventilators and fans per Section 230020. C-clamp type beam or joist hangers used to support fans must include a retainer strap to prevent clamp from slipping off beams or joists.

3.6 See Section 230930 for air balancing. Provide replacement fixed sheaves and belts where required for final air balance. Size replacement sheaves to obtain required performance.

3.7 FINAL CHECKS BEFORE START-UP

A. Remove shipping restraints, blocking, and bracing.

B. Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete.

C. Verify proper thermal overload protection is installed in motors, starters, and disconnects.

D. Verify proper motor rotation direction and that fan wheel is free to rotate and bearings operate smoothly.

E. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.

F. Verify manual and automatic volume control dampers in connected ductwork systems are in the full-open position.

3.8 Exhaust fans controlled by carbon monoxide and/or nitrogen oxide sensors shall run when sensors are triggered. When exhaust fans run, associated motorized dampers shall open.

END OF SECTION 230630
SECTION 23 06 40 - KITCHEN VENTILATION EQUIPMENT

PART 1 - GENERAL

1.1 WORK INCLUDED

   A. Furnish all labor, services, material and related items necessary to complete the kitchen ventilation equipment work indicated on the drawings and/or specified herein.

1.2 RELATED DOCUMENTS

   A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.
   B. Section 230000 - Mechanical General Conditions.
   C. Section 230010 - Basic Mechanical Materials and Methods.
   D. Section 230020 - Vibration Isolation and Seismic Restraints.
   E. Section 230900 - Air Distribution.

1.3 QUALITY CONTROL

   A. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings in accordance with AMCA Standard 210 - Laboratory Methods of Testing Fans for Rating.

   B. Vibration Levels: Comply with ANSI/AMCA Standard 204-05, "Balance Quality and Vibration Levels for Fans".

   C. Sound Power Level Ratings:
      1. Comply with AMCA Standard 301 "Method for Calculating Fan Sound Ratings From Laboratory Test Data."
      2. Test fans in accordance with AMCA Standard 300 "Test Code for Sound Rating."
      3. Fans shall be licensed to bear the AMCA Certified Sound Ratings Seal.

   D. UL Compliance:
      1. Fans and components shall be UL listed and labeled.
      2. Fans shall be designed, manufactured, and tested in accordance with UL 705 "Power Ventilators".

   E. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code".

1.4 SUBMITTALS:

   A. General: Submit the following in accordance with Section 230000.
      1. Product data for selected models, including accessories.
      2. Shop drawings detailing equipment assemblies and indicating dimensions, weights, required clearance, components, and location and size of field connections.
      4. Roof curb dimensional data and provisions for flashing.
5. Motor ratings and electrical characteristics plus motor accessories.
6. Wiring diagrams that detail power and control wiring. Differentiate between manufacturer-installed wiring and field-installed wiring.

1.5 DELIVERY, STORAGE, AND HANDLING:

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
B. Protect units on site from physical damage.
C. Deliver fan units as a factory-assembled unit to the extent allowable by shipping limitations, with protective crating and covering.

PART 2 - PRODUCTS

2.1 KITCHEN HOOD

A. Selection has been based on the manufacture scheduled to establish the desired type, quality and performance. Equivalent products by the following manufacturers complying with these specifications are acceptable: Greenheck, Denlar, or Captive Aire.

B. Kitchen ventilation hood(s) shall:

1. be of the exhaust only type, residential range hood with integral fire suppression.
2. be constructed of a minimum of 20-gauge, type 304 stainless steel with a #3 finish.
3. be constructed using the standing seam method for optimum strength.
4. have seams on the canopy that are welded liquid tight. All exposed external welds shall be ground and polished to match the original finish of the metal. Lighter material gauges, alternate material types and finishes (400 series stainless steel, cold rolled steel, etc.) and non-liquid tight welding (tack weld, spot weld, etc.) are not acceptable.
5. have construction that includes corrosion-resistant steel framing members for strength. All unexposed interior surfaces shall be constructed of a minimum 18 gauge corrosion-resistant steel, including but not limited to ducts, plenum, framing and brackets.

C. Hood filter housings and filters shall be the following type:

1. Grease baffle filters shall:
   a. be type 304 stainless steel.
   b. shall terminate in a removable drip cup.

D. Hood lighting shall:

1. Lighting Fixtures: Recessed fixture with 60W shatter-proof bulb. Include ballasts and drivers as needed for the fixture type.
   Light switches shall be mounted on hood.
2. have wiring that conforms to the requirements of the National Electrical Code (NEC #70-Latest Edition).
2.2 KITCHEN HOOD FIRE EXTINGUISHING SYSTEM

A. This Contractor shall furnish and install a wet chemical fire extinguishing system for the kitchen hood(s). System shall be Amerex. The hood(s) shall contain a factory engineered and pre-piped, U.L. Listed, Wet Chemical, Amerex 660 fire suppression system.

B. The system piping shall be installed in the hood

C. A certified local Amerex distributor shall be selected by the factory for final system hook-up. The hood manufacturer shall be responsible for the coordination between the contractor and the Amerex distributor for the final field hook-up and certification of the fire suppression system.

D. The system shall:
   1. Be capable of automatic detection and actuation and/or remote manual actuation.
   2. Have the fire suppression capabilities to protect the duct(s), plenum(s), filter area(s) and cooking equipment. Accessories shall be available for mechanical or electrical gas line shut-off applications and a double-pole, double-throw micro switch for activation of a shunt trip breaker (provided by others) for electrical equipment.
   3. Include the release assembly, agent tank, detectors, fusible links, liquid tight fittings, remote manual pull station.

E. System shall comply with the following:
   1. System shall meet the requirements of NFPA 96.
   2. System shall be the wet chemical type.
   3. System shall have duct, hood and surface protection.
   4. Audible alarm.
   5. Chemical cylinder with mechanical control.
   6. Fan speed controller

2.3 SIDEWALL KITCHEN EXHAUST FAN

A. Sidewall kitchen exhaust fan shall be provided by hood manufacturer.
   1. Fan shall have ECM motor.

PART 3 - EXECUTION

3.1 Hood and Fire Suppression System shall meet the requirements of the local authorities.

3.2 INSTALLATION

A. Wall Mounted Units: Secure to wall plate with cadmium-plated hardware.

B. Install exhaust fan a minimum of 10' away from any make-up air intakes, building walls or parapets. Fans shall be directed away from or perpendicular to building walls or parapets.

3.3 COMMISSIONING
A. Perform the following operations and checks before start-up:

1. Remove shipping, blocking, and bracing.
2. Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starter, and disconnects.
3. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operation. Align belts and install belt guards.
4. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
5. Measure and record electrical motor voltage and amperage for each phase.

END OF SECTION 230640
SECTION 23 06 72 – GAS FIRED RADIANT HEATERS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish all labor, services, material and related items necessary to complete the gas fired heater installation indicated on the drawings and/or specified herein. This section includes the following:

1.2 RELATED DOCUMENTS

A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.
B. Section 230000 - Mechanical General Conditions.
C. Section 230010 - Basic Mechanical Materials and Methods.
D. Section 230020 - Vibration Isolation and Seismic Restraints.
E. Section 230890 - Breechings, Chimneys, and Stacks.
F. Section 230961 - Temperature Controls Wiring.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Section 230000.
B. Product data including weights, dimensions, metal gauges, and data on features and components. Include plan and elevation views of units, minimum clearances, and data on ratings and capacities.
C. Wiring diagrams from manufacturers detailing requirements for electrical power and control wiring for heaters. Include ladder-type wiring diagrams for interlock and control wiring required for field installation. Differentiate between portions of wiring that are factory installed and portions that are to be field installed.
D. Data for inclusion in Operating and Maintenance Manual specified in Section 230000.

1.4 WARRANTY

A. Manufacturer’s published warranty covering all components for a period of 36 months and covering the heat exchanger for 60 months.

1.5 QUALITY ASSURANCE

A. Comply with NFPA 70, "National Electrical Code."
C. AGA Approval: Heaters design certified and labeled by the American Gas Association.

PART 2 - PRODUCTS

2.1 GAS FIRED RADIANT HEATER

A. Radiant heater selection has been based on Schwank to establish the desired style and quality. Products by the following manufacturers, complying with these specifications, are acceptable:

1. Raytec
2. Modine
3. Superior Radiant Products
4. Gordon Roberts
5. Reznor

B. Gas-fired Tubular Infrared Heaters

1. Comply with ANSI Z83.6, "Gas-Fired Infrared Heaters."
   a. AGA Approval: Design, certify, and label by American Gas Association.
   b. Unit shall burn natural gas with characteristics same as those of gas available at project site. Unit shall be designed to operate with natural gas at a minimum inlet pressure of 5 in. W.G.
   c. Gas valve shall be of the slow opening type.
   d. The burner shall be serviceable from either side.
   e. Unit shall have a two-stage gas valve rated for operation at 65% and 100%.

2. Factory assembled, piped, wired, and tested for 120 VAC.

3. Combustion Tubing shall be stainless steel or aluminized steel with high-emissivity, high-temperature, corrosion-resistant external finish. Tubing connections shall be stainless-steel couplings or flared joints with stainless-steel draw bolts.

4. Reflector:
   a. Polished aluminum, ASTM 1100, 97 percent minimum reflectivity, with end caps. Reflectors shall extend below the bottom surface of the radiant tube; shape to control radiation from tubing for uniform intensity at floor level with 100 percent cutoff above centerline of tubing. Provide for rotating reflector or heater around a horizontal axis for minimum 30-degree (0.52-radian) tilt from vertical.
   b. Reflector Extension Shields: Same material as reflectors, arranged for fixed connection to lower reflector lip and rigid support to provide 100 percent cutoff of direct radiation from tubing at angles greater than 30 degrees from vertical.
   c. Directing of radiant pattern shall be accomplished through use of side shields or bottom shields only.

5. Heater Type: Gravity vented, power burner, with the following features:
   a. Emitter Tube: Aluminized-steel tubing. Couplings shall be of aluminized steel, with two draw bands of (16ga) aluminized steel.
      1) Venting: Connector at exit end of emitter tubing for vent-pipe connection.
2) Outside air adapters and flue connectors shall be provided as standard equipment.

b. Burner/Ignition:

1) Stainless-steel burner cup and head with balanced-rotor draft fan and direct sensing, silicon-carbide hot-surface ignition. Ignition shall take place within the burner cup for reliability. Air blower motor shall be totally enclosed, require no oiling, and shall be equipped with a thermal overload switch.

2) Burner housing shall be constructed of 18ga corrosion resistant steel and coated with powder epoxy paint.

3) Burner box surface temperature shall not exceed 80°F at any point during operation.

4) Burner shall be equipped with a flame sight port safety useable while the unit is running during service.

5) Outside-Air Connection: Duct connection for combustion air to be drawn directly from outside by burner or draft fan. Provide a filter in airflow path.

6. Controls

   a. Gas and electric controls shall be separated from the combustion air stream.

   b. Air pressure proving switch shall be an integral part of burner safety control system.

   c. Control Transformer:  Integrally mounted, 120 VAC/24 VAC.

C. Radiant Heater Flues

1. Furnish and install Type B flues for radiant heaters. See section 230890 for requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation and other conditions affecting performance of unit.

B. Examine rough-in for electrical to verify actual locations of connections prior to installation.

C. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Installation and connection of gas-fired radiant heaters and associated fuel and vent features and systems installed and connected in accordance with NFPA 54, applicable local codes and regulations, and manufacturer's printed installation instructions.

B. Connect gas piping in accordance with Section 230140 "Natural Gas Piping." Connect gas piping with shut off valve and drip.
C. Connect vents in accordance with Section 230890 "Breechings, Chimneys and Stacks." Extend flue through roof or wall as indicated on plans.

D. Suspended Units: Suspend from substrate using chains, threaded rods and building attachments. Secure to unit hanger attachments. Adjust hangers so unit is plumb and level. See Section 230020 for seismic installation requirements.

E. Provide heating only thermostat.

F. Electrical Connections: The following requirements apply:
   1. Electrical power wiring is specified in Division 26.
   2. Temperature control wiring and interlock wiring is specified in specification section 230961, "Temperature Control Wiring."
   3. Grounding: Connect unit components to ground in accordance with the National Electrical Code.

G. Gas Fired Radiant Heater to be controlled by heat-only programmable thermostat.

3.3 COMMISSIONING

A. Test functions, operations, and control sequences and protective features. Adjust to assure operation is in accordance with design.

B. Correct deficiencies identified by tests and observations and retest until specified requirements are met.

3.4 CLEANING AND ADJUSTING

A. Cleaning: Upon completion of installation, inspect heaters and associated components. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer.

B. Adjusting: Make burner and other unit adjustments for optimum heating performance and efficiency. Adjust reflectors to provide optimum heat distribution for objects, personnel, and spaces served.

3.5 DEMONSTRATION

A. Training: Demonstrate adjustment, operation, and maintenance of heaters and heater systems and train Owner's personnel.

END OF SECTION 230672
SECTION 23 06 80 – ELECTRIC HEATING TERMINALS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish all labor, services, material and related items necessary to complete the electric heating terminal installation indicated on the drawings and/or specified herein.

B. Extent of electric heating terminal work is indicated by drawings and schedules and as specified herein. Types of units are as follows:

1. Wall Mounted Electric Heaters

1.2 RELATED DOCUMENTS

A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.

B. Section 230000 - Mechanical General Conditions.

C. Section 230010 - Basic Mechanical Materials and Methods.

D. Section 230020 - Vibration Isolation and Seismic Restraints.

E. Section 230961 - Temperature Control Wiring.

F. Refer to Division 26 sections for the following work; not work of this section.

1. Power supply wiring from power source to power connection on terminal unit. Include disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Section 230000.

B. Product Data: Submit manufacturer's product data indicating typical catalog of information including optional components, color selections & arrangements. Indicate mechanical and electrical service locations and requirements, specifically indicating deviations from indicated products.

C. Submit manufacturer's installation instructions.

D. Shop Drawings: Submit layout drawings of electric heating terminals and control units showing accurately scaled cross section of cabinets, views of cabinets, dimensional information, grille, bracing and reinforcing, and typical elevation.

E. Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers, and comparison of specified heat required to actual heat output provided.
F. Wiring Diagrams: Submit wiring diagrams for electrical heating terminals showing connections to electrical power feeders, and associated control wiring. Clearly differentiate between wiring which is manufacturer-installed and that which is field-installed.

G. Data for inclusion in Operating and Maintenance Manual specified in Section 230000.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of electric heating terminals of types, ratings, and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

1.5 CODES AND STANDARDS

A. Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction, and NEC as applicable to construction and installation of electric heating terminals.

B. UL Compliance: Provide electric heating terminals which are UL-listed and labeled.

C. NEMA Compliance: Provide heating terminal accessories which comply with NEMA standards.

D. NFPA Compliance: Comply with applicable requirements of NFPA 90A and B standards pertaining to construction and installation of duct heating coils.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver electric heating terminals in factory-fabricated type containers or wrappings, which properly protect terminals from damage.

B. Store electric heating terminals in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, but store above grade and enclose with watertight wrapping.

C. Handle electric heating terminals carefully to prevent damage, breaking, and scoring of finishes. Do not install damaged units or components; replace with new.

PART 2 - PRODUCTS

2.1 WALL MOUNTED ELECTRIC HEATERS

A. Manufacturers: selection has been based on Q-Mark to establish the desired style and quality. Products by the following manufacturers, complying with these specifications, are acceptable:

2. Trane
3. Berko
4. Markel
5. Indeeco

B. Fan-forced heater, with fan delay.
C. Heavy duty steel fins brazed to steel tubular elements in grid pattern which covers entire discharge area.

D. Recessed in standard 2x4 or larger wall sections.

E. Commercial grade steel grille creates downflow air pattern.

F. Totally enclosed motor, impedance protected with permanently lubricated bearings.

G. Built-in snap action thermostat.

H. Heater and electrical accessories shall be labeled by Underwriters Laboratories, Inc.

I. Neutral gray baked-on enamel finish.

J. Furnish optional disconnect switch kit, for electrical to install.

K. Electrical Power
   1. Three phase units shall be fed with a 3 wire feeder.

PART 3 - EXECUTION

3.1 Install electric heating terminal units and accessories in accordance with manufacturer's recommendations and with recognized industry practices. Comply with applicable installation requirements of NEC and NECA's "Standard of Installation".

3.2 Locate each unit accurately in the position indicated in relation to other work. Position work with sufficient clearance for normal service and maintenance, including clearance for cabinet removal.

3.3 Coordinate with the electric contractor for proper power requirements.

3.4 See Section 230961, Temperature Control Wiring, for installation of thermostats and other controls.

3.5 Clean dust and debris from each heating terminal as it is installed to ensure cleanliness. Install filters before start and before store opening.

3.6 Touch-up scratched or marred heating terminal enclosure surfaces to match original finishes.

3.7 Provide equipment grounding connections for electric heating terminals as indicated.

3.8 Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std. 486A.

3.9 Testing: Upon completion of installation of electric heating terminals, and after building circuitry has been energized, test heating terminals to demonstrate capability and compliance with requirements. Where possible, field correct malfunctioning units, then retest to
demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.

3.10 Wall mounted units shall be controlled by an integral thermostat.

END SECTION 230680
PART 1 - GENERAL

1.1 SYSTEM DESCRIPTION

A. The system shall be a variable capacity, split system, direct expansion (DX) air conditioning system. The system shall consist of multiple evaporators, refrigerant distribution piping, and a condensing unit and shall use refrigerant R-410A. Heat Recovery systems may connect indoor evaporator capacity up to 130% of the condensing unit capacity. Each evaporator on a heat recovery system shall be capable of operating separately with individual temperature control.

1. Heat Pump systems may connect indoor evaporator capacity up to 200% of the condensing unit capacity. Each evaporator on a heat pump system shall be capable of operating separately with individual temperature control except that all evaporator units must be in heating at one time or cooling depending if the condensing unit is in heating or cooling mode of operation.

B. Each system shall include a full charge of refrigerant R-410A and oil.

C. Performance: The unit selected shall operate at conditions specified in the schedule. The full load operation of the unit shall not exceed the demands indicated on the schedule. System shall provide the efficiency (EER) indicated on the plans or higher.

D. Operation of the system shall permit either individual cooling or heating of each indoor unit simultaneously or all of the indoor units associated with one branch cool/heat selector box. Each indoor unit or group of indoor units shall be able to set its set point via a local controller or an interface with the building DDC system.

1.2 REFERENCES

A. ANSI Compliance: Comply with ANSI B9.1 safety code requirements pertaining to unit construction of condensing units and condensers.


C. ANSI/NFPA 70 National Electrical Code: Comply with applicable National Electrical Code (NEC) requirements pertaining to electrical power and control wiring for construction and installation of condensing units and condensers.

D. ANSI/UL 207 - Refrigerant-Containing Components and Accessories, Non-Electrical.


F. ARI 270 - Sound Rating of Outdoor Unitary Equipment.


H. ARI 520 - Positive Displacement Refrigerant Compressors, Compressor Units and Condensing Units.
I. ASHRAE 14 - Methods of Testing for Rating Positive Displacement Condensing Units.


K. ASME Compliance: Construct and test condensing units and condensers in accordance with ASME Boiler and Pressure Vessel Code, Section 8.

L. UL Compliance: Comply with applicable requirements of UL 465, "Central Cooling Air Conditioners," pertaining to construction and installation of condensing units and condensers. Provide condensing units and condensers which are UL-listed and labeled.

1.3 RELATED DOCUMENTS

A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.

B. Section 230000 - Mechanical General Conditions

C. Section 230010 - Basic Material and Methods.

D. Section 230020 - Vibration Isolation and Seismic Restraints.

E. Section 230150 - Refrigerant Piping.

F. Section 230900 - Ductwork.

G. Section 230961 - Temperature Control Wiring.

1.4 QUALITY ASSURANCE

A. The units shall be listed by Electrical Laboratories (ETL) and bear the cETL label.

1.5 SUBMITTALS

A. Submit shop drawings, product data, and Operation and Maintenance data under provisions of Section 230000.

B. Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.

C. Product Data: Submit manufacturer's technical product data, including rated capacities, indicated EERs, weights (shipping, installed, and operating), furnished specialties and accessories; and rigging, installation, and start-up instructions.

D. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, methods of assembly of components, and location and size of each field-connection.

E. Provide templates for anchor bolt placement in concrete pad.

F. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring.
Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

G. Operation and Maintenance: Submit manufacturer’s operation and maintenance data.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver products to site and hoist in place.

B. Protect units from physical damage.

1.7 WARRANTY

A. The units shall have a manufacturer’s warranty and a labor warranty for a period of one (1) year from date of substantial completion of the project.

B. The compressors shall have a warranty of five (5) years from date of substantial completion of the project.

1.8 INSTALLATION REQUIREMENTS

A. The system shall be installed by a factory trained contractor/dealer. The bidders shall be required to submit training certification proof prior to the start of the installation.

B. Control wiring shall be installed by a factory trained contractor/dealer with minimum two (2) years’ experience installing VRF System Controls.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer and model numbers given in the schedule are intended to establish desired type, quality and performance.

1. LG
2. Mitsubishi City Multi.
3. Sanyo

B. For any manufacturer other than scheduled, Mechanical Contractor will be responsible for all changes and costs required to provide an Alternate VRF System including but not limited to:

1. Cost for Architectural, Mechanical, Electrical and Structural revisions as defined in Section 230000, Part 2, “Substitutions”, except that the proposal does not need to be submitted prior to the bid date.

2. Confirm that proposed manufacturer meets or exceeds heating requirement at zero (0)°F.

3. Provide detailed information of the alternate system efficiencies for the engineer to compare to the base system.

4. If alternate unit MCA / MOCP's exceed specified values, include cost of needed electrical feeder and equipment in price of the substitution.
5. Provide noise data for outdoor units and fan coil units to allow engineer to compare to the basis of design manufacturer.

2.2 VRF FAN COIL UNITS

A. General

1. The following criteria apply to all fan coil units:
2. Casing
   a. Factory assembled and tested.
   b. Factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protection, condensate drain pan, condensate drain pump, self-diagnostics, auto-restart function, fused time delay, and test run switch.
   c. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.
   d. Provide fresh air intake kit where indicated on the drawings.
   e. Provide a branch duct knockout for branch ducting supply air where indicated on the drawings.
   f. Condensate pump shall provide up to 21” of lift unless otherwise noted.
   g. The condensate pan shall have a built in safety alarm.

3. Controls
   a. PID control shall be used to control superheat to control the room temperature.
   b. Return air thermistor.
   c. The unit shall have controls provided by manufacturer to perform input functions necessary to operate the system.
   d. A thermistor will be located on the liquid and gas line.
   e. Provide remote “in-room” wall mounted, hard wired remote sensor.

4. Piping
   a. Unit and refrigerant pipes shall be charged with dehydrated air prior to shipment.
   b. Both refrigerant lines shall be insulated.

5. Fan
   a. The fan shall be direct-drive fan with statically and dynamically balanced impeller with high, medium, and low fan speeds.
   b. The fan motor shall comply with Section 230050, Motors, and operate on the voltage with a motor output indicated on the plans. The fan motor shall be thermally protected.
   c. The airflow rate shall be as indicated on the plans.

6. Coil
   a. Coils shall be the direct expansion type constructed from copper tubes expanded into aluminum fins. Capacity shall be as indicated on the plans. The refrigerant connections shall be flare connections.
7. Provide MERV-3 filter.
8. Electrical
   a. Each fan coil unit shall have a separate power supply at the voltage indicated on the plans.
   b. Non-fused disconnect switch.

B. 4 Way Ceiling Cassette Unit (2' X 2')
   1. Ceiling cassette fan coil unit shall be for installation into the ceiling cavity equipped with an air panel grill for supply and return air.
   2. Four-way air distribution type, ivory white, impact resistant, and washable decoration panel. Supply air shall be distributed via motorized louvers which can be horizontally and vertically adjusted from 0° to 90°. Three auto-swing positions shall be available.
   3. The 4-way supply air flow can be field modified to 3-way and 2-way airflow to accommodate various installation configurations. Return air shall be through the concentric panel, which shall include a washable, mold resistant filter.
   4. The unit’s sound pressure shall range from 25 dB(A) to 33 dB(A) at low speed measured at 5 feet below the unit.

C. Concealed Ceiling Ducted Unit
   1. The unit shall be constructed of a galvanized steel casing with a horizontal discharge air and a horizontal return air or bottom return air configuration as indicated on the plans. Switch box shall be reached from the side or bottom.
   2. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation and ducted to the supply and return openings.
   3. Fan external static pressure shall be as indicated on the plans.
   4. Unit height shall be maximum 11-7/8". Condensate drain pump shall lift a minimum of 9-13/16" from the drain pipe opening.

D. Wall Mounted Unit
   1. Unit shall be a wall mounted fan coil unit for installation onto a wall within a conditioned space.
   2. The unit shall have an auto-swing louver which ensures efficient air distribution and closes automatically when the unit stops. The remote controller shall be able to set five (5) steps of discharge angle. The front grille shall be easily removed for washing. The discharge angle shall automatically set at the same angle as the previous operation upon restart.
   3. The drain pipe can be fitted to from either left or right sides.

2.3 OUTDOOR REFRIGERATION UNIT (Condensing Unit)

A. General: The outdoor refrigeration 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, capillary tubes at suction lines, subcooling circuits and oil return lines, filters, shut off valves, oil separators, service ports and refrigerant
regulator. High/low pressure gas line, liquid and suction lines shall be individually insulated between the outdoor and indoor units.

B. The maximum connection ratio of indoor units to outdoor unit shall be up to 130%. Each outdoor system shall be able to support the connection of up to the number of indoor units indicated on the plans.

C. The system shall automatically restart operation after a power failure and shall not cause any settings to be lost.

D. The unit shall incorporate an auto-charging or an auto-check feature and a refrigerant charge check function.

E. 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.

F. The condenser shall be provided with sub-cooling to prevent flash gas ahead of expansion valves.

G. Oil recovery cycle shall be automatic.

H. The outdoor unit shall be capable of starting and heating operation at 0°F dry bulb ambient temperature without additional low ambient controls.

I. The system shall continue to provide heat to the indoor units in heating operation while in the defrost mode.

J. The unit shall be constructed from steel panels coated with a baked enamel finish.

K. The condensing unit shall consist of one or more propeller type, direct-drive fan motors that have multiple speed operation via a digitally commutating inverter. The fan shall be a vertical discharge.

L. The fan motors shall have inherent protection and permanently lubricated bearings and be mounted and shall be provided with a fan guard.

M. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins. The fins are to be covered with an anti-corrosion acrylic resin and hydrophilic film type E1. 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.

N. Scroll compressors shall be variable speed controlled and/or digital scroll type and shall change the speed to follow the variations cooling and heating load as determined by the suction gas pressure as measured in the condensing unit. Monitor evaporator and condenser temperatures control compressor capacity. Digital scroll compressors are acceptable for lead compressors.

O. The inverter driven compressor in each condensing unit shall be a hermetically sealed scroll "G-type" with a maximum speed of 7,980 rpm.
P. The capacity control range shall be as low as 6%.

Q. Each non-inverter compressor shall also be of the hermetically sealed scroll type.

R. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector. Compressors shall be spring mounted.

S. Provide oil separators together with an oil management system.

T. Provide a metal guard over the condenser coils to protect them from hail damage.

U. Units sized 6-12 tons shall contain a minimum of 2 compressors, 14 ton units shall contain a minimum of 3 compressors, and 16-20 ton units 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.

V. 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 as required by manufacturer for proper operation.

W. The power supply to the outdoor unit shall be as indicated on the plans.

X. The control wiring shall be a shielded or non-shielded as required by equipment manufacturer.

PART 3 - EXECUTION

3.1 Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances, housekeeping pads, and other conditions affecting performance of fan coil units. Do not proceed until unsatisfactory conditions have been corrected.

3.2 Install outdoor units on a curb or equipment rails to be higher than site snow depth (12” minimum).

3.3 Install fan coil units level and plumb, in accordance with manufacturer's written instructions.

3.4 Provide isolators and seismic restraints in accordance with Section 230020.

3.5 Arrange installation of fan coil units to provide access space around units for service and maintenance.

3.6 Refrigerant Piping

A. Install refrigerant piping of the sizes shown on the drawing in accordance with manufacturer's recommendations and Section 230150.

   1. Refrigerant line sets may be used for refrigerant lines up to and including 5/8 inch diameter. Only downstream of branch selector boxes.
   2. Hard drawn ACR copper piping shall be used for any lines larger than 5/8 inch.
   3. See Section 230150, Refrigerant Piping, for tolerances on refrigerant piping slope and level.
B. Charge per manufacturers specifications with R-410A. Do NOT discharge any refrigerant to the atmosphere.

C. Insulate ALL refrigerant piping. Coat all insulation exposed to sunlight. See Section 230200, Mechanical Insulation.

3.7 Duct installations and connections are specified in other Section 230900, Ductwork. Make final duct connections with flexible connections.

3.8 Connect condensate drain line and route to floor drain or as otherwise indicated on the plans.

3.9 Electrical Connections: The following requirements apply:
   A. Electrical power wiring is specified in Division 26.
   B. Temperature control wiring and interlock wiring is specified in Section 230961, Temperature Control Wiring.
   C. Grounding: Connect unit components to ground in accordance with the National Electrical Code.

3.10 Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheel and cabinet.

3.11 VRF system shall not be used to condition the building during construction. Contact manufacturer for details so as to not void the warranty.

3.12 Refer to Sections 230910, "Start-up, Cleaning and Testing" and 230930 "Testing and Balancing" for additional requirements.

3.13 System to be controlled by a central controller with web access and error email capabilities. System capable of supporting weekly schedule setting, event scheduling, and timed override to allow indoor unit operation during unoccupied periods. System shall also be capable of Auto-changeover functions and interlock control for use with third party equipment (DOAS, dampers, occupancy sensing, etc.). System shall be capable of monitoring, operating, and scheduling a maximum of 64 indoor unit groups from a networked PC web browser.

END OF SECTION 230812
SECTION 23 08 50 – FURNACES AND MATCHING CONDENSING UNITS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish all labor, services, material and related items necessary to complete the Furnace and Condensing Unit installation indicated on the drawings and/or specified herein.

B. Furnaces and condensing units shall be by the same manufacturer unless otherwise indicated.

1.2 REFERENCES

B. ARI 270 - Sound Rating of Outdoor Unitary Equipment.
C. ANSI/NFPA 70 National Electrical Code.
E. ANSI/UL 207 - Refrigerant-Containing Components and Accessories, Non-Electrical.
G. ANSI/UL 465 - Central Cooling Air Conditioners.
I. ARI 520 - Positive Displacement Refrigerant Compressors, Compressor Units and Condensing Units.

1.3 RELATED DOCUMENTS

A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.
B. Section 230000 - Mechanical General Conditions.
C. Section 230010 - Basic Mechanical Materials and Methods.
D. Section 230020 - Vibration Isolation and Seismic Restraints.
E. Section 230140 - Natural Gas Piping.
F. Section 230150 - Refrigerant Piping.
G. Section 230890 - Breechings, Chimneys, and Stacks
H. Section 230900 - Ductwork.
I. Section 230961 - Temperature Control Wiring.

1.4 QUALITY ASSURANCE

A. All units shall be rated and certified as complete units in accordance with ARI Standard 210/240-94 and shall bear the ARI seal. Cooling capacity ratings shall be based on ARI Standard 340/360-93 requirements.

B. Units, and all accessories, shall be listed by Underwriter's Laboratories, Inc. and bear the appropriate UL label.

1.5 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 230000.
B. Submit product data, manufacturer’s installation instructions and operation and maintenance data for manufactured products and assemblies required for this project.

C. Indicate electrical service and duct connections on shop drawings or product data.

D. Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver products to site and hoist in place.

B. Protect units from physical damage.

1.7 WARRANTY

A. Entire unit shall have a one year warranty as described in section 230000.

B. The compressor shall be warranted an additional four (4) years beyond the first year. The additional four years for the compressor shall be for parts only and shall not include labor.

PART 2 - PRODUCTS

2.1 FURNACE

A. Selection has been based on the manufacturer scheduled to establish the desired type, performance and quality. Equal products, complying with these specifications, by the following manufacturers are equally acceptable:

1. Carrier
2. Trane
3. Johnson Controls
4. Lennox
5. York

B. Gas furnaces shall include and/or comply with the following:

1. Unit shall be a factory fabricated, assembled and tested unit, and shall include all safety and operating controls, wiring, piping, etc. necessary for proper operation.
2. Downflow, AGA certified natural gas fired furnace.
3. Direct vent sealed combustion system with side wall terminations for combustion air and vent pipes.
4. Pilotless ignition system.
5. Annual Fuel Utilization Efficiency (AFUE) rating of 96%.
7. Control transformer.
8. Heating-cooling programmable setback thermostat with battery back-up, digital clock and manual override.
9. Multiple speed fan motor with cooling relay.
10. Copper tube, aluminum fin evaporator coil assembly with galvanized drain pan and drain connection. Provide capillary tubes or thermostatic expansion valves for units of 6
tons capacity and less, and thermostatic expansion valves and alternate row circuiting for units 7.5 tons cooling capacity and larger.

11. Twinning kit for units indicated on the plans to allow two furnaces to operate as a single unit.
12. Provide CPVC condensate drain piping to connect furnace condensate trap to cooling coil drain line.
13. Provide CPVC flue exhaust piping and CPVC intake piping and screened intake and exhaust connections.


1. Refrigerant Coil Enclosure: Steel, matching furnace and evaporator coil, with access panel and flanges for integral mounting at or on furnace cabinet and galvanized sheet metal drain pan coated with black asphaltic base paint.
2. Configuration: Up feed with bottom suction to prevent trapping of oil.

D. Cooling Coil Drain Pans:

1. Provide 20 gage galvanized steel drain pan for cooling coils with soldered corners or cold galvanized coating on corners. Minimum 3 inches deep; extend 3 inches from face of coil entering air side and 6 inches from face of coil leaving air; extend on sides of coil bank to 1 inch beyond the greatest projection of coil headers and tube return.
2. Slope pan to the drain connection at minimum 1/8" per foot in direction of airflow. Accommodation for deflection of pan and pan supports shall be made to prevent condensate from standing in drain pans.
3. Provide one 1-1/2" drain pipe connection.
4. Insulate exterior of drain pan with 3/4" thick closed cell rubber to prevent condensation.

E. Miscellaneous Features

1. Filters - Provide 2" Throwaway Filters. Provide access from side panel for removal. Filter rack shall be field converted to two inch capability with field provided filters.
2. Thermostats: Provide 24 volt operation control, factory-supplied and field-installed. Heating-cooling programmable setback thermostat with battery back-up, digital clock and manual override. Provide number of heating and cooling steps indicated or required to match condensing unit. Include system selector switch (off-heat-auto-cool) automatic changeover and fan control switch (auto-on).
3. Vibration Isolators: Provide neoprene floor-mounted isolators to reduce transmission of noise and vibration to building structures.

2.2 Air Cooled Condensing Unit

A. Selection has been based on the manufacturer scheduled to establish the desired type, performance and quality. Equal products, complying with these specifications, by the following manufacturers are equally acceptable:

1. Carrier
2. Trane
3. York
4. Lennox
5. Johnson Controls

B. Air cooled condensing unit shall include and/or comply with the following:

1. Unit shall be a factory fabricated, assembled and tested unit, and shall include all safety and operating controls, wiring, piping, etc., assembled in such a manner that the only field connections required are refrigerant suction, refrigerant liquid, electrical power, and control connections.

2. Casing shall make unit fully weatherproof for outdoor installation. Casing shall be fabricated from galvanized steel and shall have a factory applied baked enamel finish. All edges of the metal shall have the same finish to protect the material from rusting. Openings shall be provided for power and refrigerant connections. Panels shall be removable to provide access for servicing.

3. Condenser coil shall be fabricated from copper tubes with mechanically bonded aluminum fins. Coil shall be circuited for subcooling.

4. Condenser fans shall be direct driven propeller type. Each fan shall have a fan guard. Fan motors shall have inherent protection, shall be resiliently mounted, and shall have permanently lubricated bearings.

5. Refrigerant system shall include a filter drier, suction and liquid line service valves with pressure taps and charging connections.

6. Compressors shall comply with the following:
   a. Shall be the serviceable hermetic type.
   b. Internal and external vibration isolators.
   c. Compressor shall include a crankcase heater.
   d. Compressor shall include discharge and suction shutoff valves.

7. Condensing unit shall include the following controls:
   a. High head pressure cutout.
   b. Low suction pressure cutout.
   c. Timer to prevent short cycling of compressors.
   d. Condenser fan controls.

8. Condensing units, where indicated on the plans, shall include the following options:
   a. Head pressure controls suitable to allow operation down to 0°F.
   b. Winter start controls to allow compressor start to 0°F ambient.
   c. Liquid line solenoid valve.

9. Condensing unit shall comply with the following standards:
   a. Ratings shall be in compliance with ARI 520.
c. Wiring shall comply with the National Electrical Code.
d. Unit shall be ETL or UL listed.

10. Unit wiring shall include:
   a. Field power connection, control interlock terminals and unit control system shall be located in a weatherproof enclosure. Panel access doors shall key lock. Dead-front panels shall be provided on the line voltage side.
   b. Control circuit transformer and fusing.
   c. Positive acting timer to prevent short cycling of compressor (approx. 5 minutes).

11. Condensing unit shall have condenser fans with a vertical discharge.

12. Condenser Coil Hail guard.

13. Condensing unit shall have a minimum SEER rating of 16.

PART 3 - EXECUTION

3.1 INSTALLATION OF FURNACE

A. Install units, where indicated on drawings, in accordance with manufacturer's published installation instructions, with recommended clearances provided for service and maintenance.

B. Support units as described below, using the vibration control devices indicated.

1. Suspended Units: Units shall be suspended from structure using threaded steel rods, double nuts with lockwashers, and vibration isolators. Provide sway bracing in accordance with requirements of section 230020.

C. Connect ductwork with a flexible connector and connect condensate drain line. Route condensate drain to floor drain.

D. Provide secondary drain pan under the unit per details on the plans.

E. Arrange installation of units to provide access space around air-handling units for service and maintenance.

F. Replace filters with new filters before air balance for any units that have been operated during construction.

G. Install intake and exhaust piping to sealed combustion chamber.

H. Connect natural gas piping, ductwork and condensate drain line. Route Install drain piping from the sealed combustion chamber to a sanitary drain.

I. Install drain piping from the sealed combustion chamber to a sanitary drain. Provide a JJM Boiler Works, JM series, condensate neutralization tube in the line between the furnace and the sanitary drain.

J. Mounting for the furnace shall be able to withstand 50 lb lateral force.
3.2 INSTALLATION OF CONDENSING UNITS
   A. Install units, where indicated on drawings, in accordance with manufacturer's published installation instructions, with recommended clearances provided for service and maintenance.
   B. Condensing units shall be located on concrete pad provided by this contractor.

3.3 REFRIGERANT PIPING
   A. Install refrigerant piping of the sizes shown on the drawing in accordance with manufacturer's recommendations and Section 230150.
   B. Charge per manufacturers specifications with R-410a. Do NOT discharge any refrigerant to the atmosphere.
   C. Insulate suction piping. Paint all insulation exposed to sunlight.

3.4 ELECTRICAL CONNECTIONS: THE FOLLOWING REQUIREMENTS APPLY:
   A. Electrical power wiring is specified in Division 26.
   B. Temperature control wiring and interlock wiring is specified in Section 230961, Temperature Controls Wiring.

   END OF SECTION 230850
SECTION 23 08 90 – BREECHINGS, CHIMNEY AND STACKS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish all labor, services, material and related items necessary to complete the HVAC heating system installation indicated on the drawings and/or specified herein.

B. Extent of work required by this section is indicated on schedules, and by requirements of this section.

1.2 SECTION INCLUDES

A. Manufactured chimneys for gas fired equipment.

B. Breechings.

C. Combustion air intakes for gas fired equipment.

1.3 RELATED DOCUMENTS

A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.

B. Section 230000 - Mechanical General Conditions.

C. Section 230010 - Mechanical Basic Materials and Methods.

D. Section 230020 - Vibration Isolation and Seismic Restraints.

1.4 REFERENCES

A. ANSI/ASTM A525 - Steel Sheet, Zinc-Coated (Galvanized) by the Hot- Dip Process, General Requirements.


E. ASTM A527 - Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock-Forming Quality.

F. ASTM D 1784 - Chlorinated PolyVinyl Chloride (CPVC)Pipe and Fittings

G. ASTM D 1785 - Poly Vinyl Chloride Plastic Pipe, Schedules 40, 80, and 120

H. ASTM D 2665 - PolyVinyl Chloride (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
I. ASTM D 2855/ ASTM D 2564 - Plastic Solvent Cement for PVC Plastic Pipe
J. ASTM F 438 - Socket-Type Chlorinated PolyVinyl Chloride (CPVC) Plastic Pipe Fittings, Schedule 40
K. ASTM F 441 - Chlorinated PolyVinyl Chloride (CPVC) Plastic Pipe, Schedules 40 and 80
N. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
O. UL 103 - Standard for Factory Built Low Heat Chimneys.
P. UL 378 - Standard for Draft Equipment.
Q. UL 441 - Standard for Gas Vents.

1.5 DEFINITIONS
A. Breeching: Vent Connector.
B. Chimney: Primarily vertical shaft enclosing at least one vent for conducting flue gases outdoors.
C. Smoke Pipe: Round, single wall vent connector.
D. Vent: That portion of a venting system designed to convey flue gases directly outdoors from a vent connector or from an appliance when a vent connector is not used.
E. Vent Connector: That part of a venting system that conducts the flue gases from the flue collar of an appliance to a chimney or vent, and may include a draft control device.

1.6 Design Requirements: Factory built vents and chimneys used for venting natural draft appliances shall comply with NFPA 211 and be UL listed and labeled.

1.7 SUBMITTALS
A. Submit shop drawings, product data, and manufacturer’s installation instructions data under provisions of Section 230000.
B. Submit shop drawings indicating general construction, dimensions, weights, support and layout of breechings. Where factory built units are used submit layout Drawings indicating plan view and elevations.
C. Submit product data indicating factory built chimneys, including dimensional details of components and flue caps, dimensions and weights.

1.8 Conform to applicable code for installation of natural gas burning appliances and equipment.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Selkirk Metalbestos
B. American Metal Products
C. Barron
D. Schebler

2.2 TYPE B DOUBLE WALL GAS VENTS

A. Fabricate inner pipe of sheet aluminum, and outer pipe of galvanized sheet steel, tested in compliance with UL 441.

B. Description: Double wall gas vents, UL listed for Type B, consisting of an inner pipe of sheet aluminum, and outer pipe of galvanized sheet steel, with the following minimum thicknesses:

<table>
<thead>
<tr>
<th>Size</th>
<th>Inner Pipe</th>
<th>Outer Pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Round, up to 6”</td>
<td>0.0012”</td>
<td>28 gauge</td>
</tr>
<tr>
<td>Round, 7” to 18”</td>
<td>0.0014”</td>
<td>28 gauge</td>
</tr>
<tr>
<td>Round, 20” to 24”</td>
<td>0.0018”</td>
<td>26 gauge</td>
</tr>
<tr>
<td>Oval, up to 4”</td>
<td>0.0012”</td>
<td>28 gauge</td>
</tr>
<tr>
<td>Oval, 5” to 6”</td>
<td>0.0014”</td>
<td>28 gauge</td>
</tr>
</tbody>
</table>

C. Accessories: UL labeled tees, elbows, increasers, draft hood connectors, metal cap with bird barrier, adjustable roof flashing, storm collar, support assembly, thimbles, clean-outs, fire stop spacers, and fasteners, fabricated of similar materials and designs as vent pipe straight sections.

1. Install electrically actuated vent dampers that are provided with the boiler in compliance with ANSI Z21.66.

2.3 VENT CONNECTOR


B. Fabricate connectors and fittings from following minimum gages. Refer to SMACNA HVAC Duct Construction Standards - Metal and Flexible.

1. Sizes up to 9 inches: 24 gauge.
2. Sizes 10 inches to 16 inches: 22 gauge.

C. Provide adjustable self-actuating barometric draft dampers, where indicated, full size of breeching.

D. Provide cleanout doors of same gage as breeching, where indicated on Drawings.

E. For connectors less than 24 inches diameter provide groove seam (pipe lock or flat lock) with end joints beaded and crimped.
F. Fabricate connector fittings to match adjoining connectors. Fabricate elbows with center-line radius equal to connector width. Limit angular tapers to 20 degrees maximum.

2.4 POSITIVE PRESSURE STACK

A. Provide a factory built modular connector, manifold and stack system for stacks located on the discharge side of flue fans.

B. Stacks shall be laboratory test and listed by Underwriters laboratories for use with building heating equipment which produce exhausted flue gases at a temperature not exceeding 1,000 degrees F. under continuous operating conditions and not exceeding 1,400 degrees F under intermittent operating conditions in accordance with NFPA 211.

C. The system shall be designed and installed to be gas tight and prevent leakage into a building. The system shall compensate for all flue gas induced thermal expansion. Provide manufacturer recommended accessories such as guying supports.

D. The stack wall shall be double wall construction with an inner pipe of 304 stainless steel and an outer wall of aluminum coated steel. The nominal space between the walls shall be one (1) inch.

E. The inner pipe joints shall be sealed with factory supplied V bands and sealant approved by the manufacturer.

F. Roof penetrations shall be provided with a storm collar for non-combustible roof construction and with a ventilated thimble for combustible roof construction.

G. Include the following accessories as needed: U.L. labeled tees, elbows, increasers, metal cap with bird barrier, adjustable roof flashing, storm collar, support assembly, thimbles, clean-outs, fire stop spacers, and fasteners. Fabricate of similar materials and design as vent pipe straight sections.

H. Stack shall be Metalbestos Model PS or approved equal.

2.5 BREECHING

A. Breeching shall be constructed from 10 gauge carbon steel with all joints continuously welded.

B. Sections shall be joined by either continuous welds or by bolted flanged joints. Flanged joints shall be gasketed and sealed gas tight using heat resistant gaskets.

C. Breeching shall be insulated with Code (2) insulation. See specification section titled "Thermal Insulation".

D. Completed installation shall comply with NFPA 211.

2.6 FLUE FOR HIGH EFFICIENCY WATER HEATERS AND FURNACES

A. Chlorinated Poly-Vinyl Chloride Plastic Pipe: Schedule 40, complying with ASTM F 441/F 441M. CPVC plastic fittings, schedule 40 or 80 per manufacturer requirements, complying with ASTM F 438, socket type. CPVC solvent cement, ASTM F 493.
B. Combination combustion air intake and vent: PVC plastic fitting to combine combustion air inlet and vent thru roof.

C. Flue shall be Saf-T Vent CI Plus by Heatfab, Inc. or approved equal.

2.7 INTAKE FOR HIGH EFFICIENCY WATER HEATER AND FURNACES

A. Poly-vinyl Chloride Pipe and Fittings: (except not allowed in ceiling plenums)
   1. PVC schedule 40 pipe with plain ends: ASTM D-2665.

B. Chlorinated Poly-vinyl Chloride Pipe and Fittings: (for use in ceiling plenums)
   1. CPVC schedule 40 pipe with plain ends and fittings: Spears Lab Waste CPVC complying with ASTM D-1784 and ULC listed as equal to ASTM E-84 having a flame spread rating of less than 25 and a smoke developed rating of less than 50.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions and UL listing.


C. Support breechings from building structure, rigidly with suitable ties, braces, hangers and anchors to hold to shape and prevent buckling. Support vertical breechings, chimneys, and stacks at 12 foot spacing, to adjacent structural surfaces, or at floor penetrations. Refer to SMACNA HVAC Duct Construction Standards - Metal and Flexible for equivalent duct support configuration and size. Provide seismic supports requirements for the seismic zone listed in section 230000.

D. Pitch vent connectors with positive slope of 1/4" per foot up from fuel-fired equipment to chimney or stack.

E. Positive Pressure Stack, maintain UL listed minimum clearances from combustibles. Assemble pipe and accessories as required for complete installation.

F. Install vent dampers, locating close to draft hood collar, and secured to breeching.

G. Level and plumb chimney and stacks.

H. Clean connectors, breechings, chimneys, and stacks during installation, removing dust and debris.

I. At appliances, provide slip joints permitting removal of appliances without removal or dismantling of connectors, breechings, chimneys, or stacks.
J. Coordinate opening in roof for installation of stack with roofer. Provide flashing.

K. Seal vent connector, where indicated or where connector will be under positive pressure, with 550 deg. F silicone sealant approved for the application by the appliance manufacturer. Seal all transverse and longitudinal points.

L. For PVC and CPVC intakes and vents, install Spears LabWaste CPVC where pipes pass through plenum rated ceilings.

3.2 CHIMNEY / STACK SCHEDULE

<table>
<thead>
<tr>
<th>EQUIPMENT</th>
<th>CHIMNEY / STACK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit Heater (with Power Ventilator)</td>
<td>Positive Pressure Stack</td>
</tr>
<tr>
<td>Water Heater (high eff./condensing)</td>
<td>CPVC Pipe</td>
</tr>
<tr>
<td>Furnace (high eff./condensing)</td>
<td>CPVC Pipe</td>
</tr>
</tbody>
</table>

3.3 Combustion Air Intake Schedule

<table>
<thead>
<tr>
<th>EQUIPMENT</th>
<th>COMBUTION AIR INTAKE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit Heater (with Power Ventilator)</td>
<td>PVC pipe or CPVC pipe for ceiling plenums</td>
</tr>
<tr>
<td>Water Heater (high eff./condensing)</td>
<td>PVC pipe or CPVC pipe for ceiling plenums</td>
</tr>
<tr>
<td>Furnace (high eff./condensing)</td>
<td>PVC pipe or CPVC pipe for ceiling plenums</td>
</tr>
</tbody>
</table>

END OF SECTION 230890
SECTION 23 09 00 – AIR DISTRIBUTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section includes rectangular and round metal ducts and plenums for heating, ventilating, and air conditioning systems in pressure classes from minus 2 inches to plus 10 inches water gauge.

B. Furnish all labor, services, material and related items necessary to complete the ductwork installation indicated on the drawings and specified herein.

1.2 RELATED DOCUMENTS

A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.

B. Section 230000 - Mechanical General Conditions.

C. Section 230010 - Basic Materials and Methods.

D. Section 230020 - Vibration Isolation and Seismic Restraints.

E. Section 230200 - Mechanical Insulation - external duct insulation.

F. Section 230930 - Testing and Balancing.

G. Section 230961 - Temperature Control Wiring - motorized dampers.

H. Section 260721 - Fire Alarm System – Addressable, for smoke detectors.

1.3 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only. Latest edition shall apply unless otherwise indicated.

B. AMCA 500 - Test Method and Louvers, Dampers and Shutters.

C. ASTM A 36 - Carbon Structural Steel.

D. ASTM A 167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.


F. ASTM A 480 - General Requirements for Flat-Rolled Stainless Steel, Sheet and Strip.

G. ASTM A 525 - General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.

H. ASTM A 527 - Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality.

I. ASTM A 568 - Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled.

J. ASTM A 569 - Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip, Commercial Quality.


M. AWS D9.1 - Welding of Sheet Metal.

N. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.


T. UL 555 - Standard for Fire Dampers.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Section 230000.

B. Product data including materials, details of construction, dimensions of individual components, profiles, manufacturer's installation instructions, and finishes for the following items:

1. Air Devices: Submit schedule of outlets and inlets indicating type, size, accessories, finish/color, type of mounting, air performance, static pressure drop, throw, and noise level.
2. Duct Liner
3. Sealant and Gasket Materials
4. Fire-Stopping Materials
5. Flexible ducts and clamps, with manufacturer's installation instructions
6. Flexible Connectors
7. Fire Dampers and Sleeves
8. Backdraft Dampers
9. Balance Dampers
10. Access Doors
11. Louvers

C. Ductwork Reinforcement Information: Submit information on the duct reinforcement to be used for each section of duct. Information shall include copies of tables from SMACNA construction standards highlighting the actual duct sizes, pressure class, material, gauge, reinforcement type and spacing, joint type and spacing, applied loads, and hanger type and spacing. When alternate methods of sizing are used as provided by SMACNA, provide calculations to support the reinforcement selection.

D. Proposed deviations of materials and methods from these specifications require approved submittal information prior to any construction. Submittals should clearly note that the submittals is for a change to the specifications and identify the applicable paragraph from this specification. Submittals shall include physical descriptions and results of testing and analysis to support the equal performance of the substituted items. Testing and analysis shall follow the guidelines for "Functional Criteria" from SMACNA standards.

E. Record drawings indicating duct actual routing in accordance with Section 230000.

F. Duct leakage testing confirming compliance with tests required for ducts over 2 inches WG pressure class.
1.5 QUALITY ASSURANCE

A. Perform Work in accordance with SMACNA 2005 - HVAC Duct Construction Standards - Metal and Flexible.

B. Manufacturer Qualifications: Company specializing in manufacturing Products specified with minimum 5 years documented experience.

C. Installer Qualifications: Company specializing in performing the Work of this Section with minimum 5 years documented experience.

D. Regulatory Requirements: Construct ductwork to NFPA 90A and NFPA 96 standards.

E. Duct Sealing, Air Leakage Criteria, and Air Leakage Tests:
   1. All ducts over 2 inches WG pressure class shall meet requirements of seal class A in Section 1 of SMACNA HVAC Air Duct Leakage Test Manual.
   2. All ducts 2 inches w.g. pressure class or less shall meet requirements of seal class C.

1.6 DELIVERY, STORAGE AND HANDLING

A. Section 016000 - Product Requirements: Transport, handle, store, and protect Products.

B. Protect dampers from damage to operating linkages and blades.

C. Deliver sealant and fire-stopping materials to site in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.

D. Store and handle sealant and fire-stopping materials in compliance with manufacturer’s recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.7 Sheet metal work as shown on plans is schematic and is based on the specified manufacturer’s equipment and material dimensions. Contractor shall make accurate measurements in the field prior to duct work fabrication and shall provide all necessary offsets and transition pieces required to accommodate actual structural and equipment variations.

1.8 The duct system design, as indicated, has been used to select and size air moving and distribution equipment and other components of the air system. Changes or alterations to the layout or configuration of the duct system must be specifically approved in writing to the Engineer.

1.9 At contractor’s option, round duct may be substituted for rectangular construction and vice versa. Equivalent round duct sizes shall be in accordance with ASHRAE Fundamentals 2009, chapter 21, Table 2. Contractor shall be responsible for coordination with other trades and any subsequent costs incurred by others for substituting round and rectangular ductwork.

1.10 Rectangular duct dimensions are sheet metal dimensions. For those ducts with internal liner, the duct dimensions include the liner.

1.11 Round duct dimensions are inside, free area dimensions.
1.12 The work shall be coordinated with that of other trades in such a manner that when the installation is complete, all items are properly installed and are serviceable.

1.13 Static Pressure Classifications: Except where otherwise indicated, construct duct systems to the following pressure classifications:

A. Supply Ducts for non VAV systems: 2 inches water gauge.
B. Return and Relief Ducts: 2 inch water gauge, negative pressure.
C. Outside Air Ducts: 2 inch water gauge, negative pressure.
D. Supply Ducts from Energy Recovery Units: 2 inch water gauge, positive or negative pressure.
E. Exhaust Ducts on Suction Side of an Exhaust Fan: 2 inches water gauge, negative pressure.
F. Exhaust Ducts on Discharge of an Exhaust Fan to building exterior: 2 inch water gauge.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Supply, return, outside air, and relief air ductwork for HVAC systems, Exhaust ductwork (except where otherwise indicated below), and Supply ductwork to kitchen hood systems shall be constructed of:

2. Provide mill phosphatized finish for ducts exposed to view that are to be painted.
3. Reinforcement, Support, Hanger, and Trapeze Shapes and Plates:
   a. ASTM A 36/A 36M, steel plates, shapes, and bars. Unless otherwise indicated, provide galvanized finish of fabricated plates, shapes, and bars or provide fabricated plates, shapes, and bars of the same material as the sheet metal ducts.
   b. Strut-Channels: Duct reinforcements, supports, and trapeze hangers may alternatively be a bolted metal framing system equal to B-Line. The system shall be channels, fittings and hardware as defined and tested in accordance with the Metal Framing Manufacturers Association Standard Publication MFMA.
      1) Channels shall be epoxy coated or electrogalvanized zinc coated and made from steel meeting ASTM A570, Grade 33. Hot dip galvanizing after fabrication shall be in accordance with ASTM A123.
   c. Where the galvanic index of the reinforcements, supports, hangers, or trapeze and the duct materials is greater than 0.15 volts (galvanized-steel plates, shapes, bars, or struts are used to reinforce aluminum or stainless steel ducts), isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

B. Exhaust ductwork kitchen hood exhaust systems shall be constructed of:

1. Aluminum Sheet, ASTM B 209, alloys 1100, 3003, or 5052.
2. Reinforcement Shapes and Plates: Unless otherwise indicated, provide reinforcing of structural shapes fabricated from the same material as the sheet metal ducts or structural shapes fabricated from galvanized steel coated with zinc chromate.
C. All materials used shall meet the requirements of NFPA 90A and UL 181 for Class I air ductwork.

D. Minimum Sheet Metal Gauges for Ductwork:

1. Rectangular ductwork shall be fabricated from the following minimum thicknesses, regardless of duct construction methods, for sizes indicated:

<table>
<thead>
<tr>
<th>Max. Long Side Dimension</th>
<th>Steel Gauge</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-12 inches</td>
<td>26</td>
</tr>
<tr>
<td>13-30 inches</td>
<td>24</td>
</tr>
<tr>
<td>31-54 inches</td>
<td>22</td>
</tr>
<tr>
<td>55-84 inches</td>
<td>20</td>
</tr>
<tr>
<td>85 inches and above</td>
<td>18</td>
</tr>
</tbody>
</table>

2. Round ductwork shall be fabricated from the following minimum gauges for sizes indicated: (Round ductwork shall not be allowed for ducts over 84".)

<table>
<thead>
<tr>
<th>Max. Long Side Dimension</th>
<th>Steel Gauge</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-12 inches</td>
<td>26</td>
</tr>
<tr>
<td>13-21 inches</td>
<td>24</td>
</tr>
<tr>
<td>22-35 inches</td>
<td>22</td>
</tr>
<tr>
<td>36-49 inches</td>
<td>20</td>
</tr>
<tr>
<td>50-59 inches</td>
<td>18</td>
</tr>
<tr>
<td>60-84 inches</td>
<td>16</td>
</tr>
</tbody>
</table>

3. Minimum gauges for stainless steel shall be the same as listed for steel.

4. Minimum thickness and reinforcement for aluminum shall be as indicated in SMACNA 2005 Table 2-50, 2-51 and 2-52 for rectangular - ducts and 3-14, 2-51, and 2-52 for round ducts.

E. Sealants:

1. Joint and Seam Sealant: One-part, nonsag, water based, vinyl acrylic sealant complying with ASTM C-731 and D-2202, rated for indoor and outdoor use, viscosity greater than 350,000 c.p.s, rated per ASTM E-84 with flame spread and smoke developed ratings of 0, formulated with a minimum of 63 percent solids. Carlisle - Hardcast Iron Grip IG-601 or equal.

2. Flanged Joint Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer. Rated per ASTM E-84 with maximum flame spread and smoke developed ratings of 10. Ductmate 5511M for attaching flanges to ducts, Ductmate 440 tape for flange to flange joints, or approved equal.

3. Isolation Gaskets: Butyl rubber, neoprene, silicone rubber, or EPDM polymer with polyisobutylene plasticizer. Rated per ASTM E-84 with maximum flame spread and smoke developed ratings of 10.

4. Slip On Flange Joint Mastic: Non-drying, non-skinning, polymer base, pumpable sealant. ASTM E-84 with maximum flame spread and smoke developed ratings of 5. Ductmate 5511M for attaching slip on flanges to ducts or approved equal.
5. Fire-Resistant Sealants for filling openings around duct penetrations through walls and floors shall be as specified in Section 230010, Basic Mechanical Materials and Methods.

6. General Sealant: One-part, acid-curing, Silicone, elastomeric joint sealant, complying with ASTM C 920, Type S (single component), Grade NS (nonsag), Class 25, Use O. Provide one of the following:

   a. Chem-Calk 1200; Bostik Inc.
   b. 999-A; Dow Corning.
   c. Construction 1200 or Contractors SCS1000 or SCS1702F; GE Silicones.
   d. HiFlex 392 or NuFlex 302; NUCO Industries, Inc.
   e. HM 270; Ohio Sealants, Inc.
   f. 860 or 863; Pecora Corporation.
   g. Tremsil 300; Tremco.

F. Acoustical Joint Sealants:

1. Applications: Seal joints in drywall sound enclosures as indicated on the sound enclosure details.

2. Acoustical Sealant for Exposed and Concealed Joints: Provide manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product shall effectively reduce airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90. Products: Provide one of the following:

   a. AC-20 FTR Acoustical and Insulation Sealant; Pecora Corporation.
   b. BA-98; Pecora Corporation.

3. Acoustical Sealant for Concealed Joints: For each product of this description indicated in the Acoustical Joint-Sealant Schedule at the end of Part 3, provide manufacturer's standard, nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant recommended for sealing interior concealed joints to reduce airborne sound transmission. Provide one of the following:

   a. SHEETROCK Acoustical Sealant; USG Corp., United States Gypsum Co.
   b. Pro-Series SC-170 Rubber Base Sound Sealant; Ohio Sealants, Inc.
   c. Tremco Acoustical Sealant; Tremco.

2.2 SINGLE WALL RECTANGULAR DUCT FABRICATION

A. Fabricate rectangular ducts in accordance with SMACNA 2005 Tables 2-1 through 2-48, including their associated details, and the Model Specifications shown in SMACNA 2005, except where this specification requires otherwise. Conform to the requirements in the referenced standard for metal thickness (except comply with minimum gages show above), reinforcing types and intervals, tie rod applications, and joint types and intervals.

B. All reinforcements between transverse joints for duct dimension greater than 36 inches shall extend past the edge of the duct and be secured with an approved tie rod or tie angle as generally shown in SMACNA 2005 Figure 2-12 for "tie alternatives for two side reinforcements".
C. Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.

D. Where Ductmate (or equal) joints are used, they shall be rated as reinforcing class “F” for Ductmate 25, reinforcing class “G” for Ductmate 35, or reinforcing class “H” for Ductmate 45 and integrated with the requirements of SMACNA Tables 2-1 through 2-28. Similar tables from Ductmate Industries shall not be substituted for the SMACNA 2005 tables. Ductmate joints shall be installed in compliance with the manufacturer’s recommendations.

E. Provide materials that are free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.

F. Crossbreaking or Cross Beading: Crossbreak or bead duct sides that are 19 inches and larger and are 20 gauge or less, with more than 10 sq. ft. of unbraced panel area, as indicated in SMACNA 2005 Figure 2-9, unless they are lined or are externally insulated.

G. Tie Rods:
   1. Internal tie rods shall be allowed for ducts 36" wide and wider. Midpanel tie rods shall be allowed for ducts 36" wide through 96" wide.
      a. Internal tie rods and midpanel ties shall not be allowed:
         1) Within 20 feet of a fan discharge or fan inlet.
         2) In kitchen hood exhaust ducts.
         3) In Fume exhaust ducts.
         4) In underground, in-slab, or under slab ducts.
         5) In fittings with non-parallel sides unless they have load distributing means such as wedges.
         6) In ducts with duct liner.
         7) For oval ducts, aluminum ducts or polyvinyl coated steel ducts, unless otherwise noted on the drawings.
   2. The maximum internal tie rod diameter shall be 3/4"; straps used for tie rods shall be maximum 1/8" thick and shall be installed with the thickness facing the air flow; angles or other structural shapes shall not be used for internal tie rods. Tie rods shall be attached to ducts in accordance with SMACNA 2005, Figures 2-5 and 2-6.
   3. Threaded inserts placed in pipes, tubes and conduits shall be secure for 200% of the loads indicated in SMACNA 2005, Table 2-34.
   4. Where internal ties occur in two directions, they shall be either prevented from contacting or be permanently fastened together.

H. Singular Wall Rectangular Duct Fittings:
   1. Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA 2005 Figures 4-1 through 4-9 and 7-1 through 7-4.
   2. All rectangular duct elbows shall be radiused in accordance with SMACNA Figure 4.2 type RE-1 (centerline radius equal to 1.5 x W) unless otherwise indicated.
a. Other Fitting Types:

1) Provide radius elbows with vanes, Figure 4.2 Type RE-3, where indicated and in accordance with details shown; minimum inner radius shall be equal to 0.5 x W unless otherwise shown; two (2) or three (3) internal vanes shall be provided as indicated on the drawings per Figure 4-9 and spaced per Chart 4-1.

2) Rectangular square throat duct elbows shall be provided only where indicated and shall:
   a) Provide single thickness, 4.5" radius turning vanes for vane lengths up to 36 inches and double thickness, 4.5" radius turning vanes for vane lengths over 36 inches, in accordance with SMACNA Figure 4-2 Type RE-2 and Figure 4.3. Spot weld vanes to end runners and screw runners to elbow cheeks with screws on 8 inch centers. Support vanes per SMACNA Figure 4-4.

2.3 SINGLE WALL ROUND DUCT FABRICATION

A. Round ductwork shall be spiral lockseam construction as detailed in Fig. 3-1 of SMACNA 2005, unless otherwise indicated, and shall comply with minimum gauges indicated above and be reinforced per SMACNA 2005 Tables 3-5 through 3-13 for the pressure ratings indicated.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Lindab Inc.
   2. McGill AirFlow LLC.
   3. SEMCO Incorporated.
   4. an approved local fabricator.

C. Except where interrupted by fittings, provide round ducts in lengths not less than 12 feet.

D. Transverse joints shall be beaded sleeve joints (type RT-1) as detailed in Fig. 3-1 of SMACNA 2005; vanstone flanges (type RT-2); welded, companion angle flanges (type RT-2A); or slip on flanges.
   1. Type RT-1 joints shall be secured with sheet metal screws as described in Fig. 3-1. Seal with joint and seam sealant.
   2. Type RT-2 joints (vanstone angles) shall have a minimum 3/8" flange on the duct with a continuous, rolled, back up angle. Provide a 3/16" thick Flanged Joint Gasket between the flanges.
   3. Type RT-2A joints (companion angle) shall have a continuous weld at the end juncture of the duct and the flange and shall have tack welds on 8" centers at the back leg of the angle flange. Provide a 3/16" thick Flanged Joint Gasket between the flanges.
   4. Slip on flanges shall be Ductmate Econoflange, Semco Accuflange, or approved equal and shall only be used within their ratings. Provide a 3/16" thick Flanged Joint Gasket between the flanges and apply Slip on Flange Joint Mastic.
E. Attach reinforcing angles as detailed in Fig. 3-1-RT-2A of SMACNA 2005. Reinforcing rings and companion flange joints shall be as indicated in Tables 3-2, 3-3, and 3-4.

F. Branch connections shall be made with 90° conical and 45° straight taps as shown on the drawings. All branch connections for new ducts shall be made as a separate fitting; saddle taps may be used for fittings that are added to existing ducts.

1. Where saddle taps are installed on existing ducts, the opening in the main duct shall closely match the saddle tap inlet opening. The entrance to the saddle tap shall have no excess material projecting into branch tap entrance. No burrs or rough welds will be allowed.
2. The saddle tap shall be attached to the main duct with welds or screws on 3" centers maximum and the joint shall be sealed.

G. Runouts to Air Devices:

1. In lieu of spiral lockseam construction, runouts may be fabricated with snaplock longitudinal joints (type RL-8) as detailed in Fig. 3-1 of SMACNA 2005. Transverse joints shall be either beaded sleeve joints (type RT-1) or crimp joints (type RT-5) as detailed in Fig. 3-1 and secured with sheet metal screws as indicated in the SMACNA details.
2. Elbows for Runouts to Air Devices: Adjustable (Gored) Elbows may be used for supply ducts only at maximum 2 inch pressure class, minimum 4 piece construction, and maximum 18" diameter.
3. Seal all joints. Fabricate with minimum 24 gauge galvanized steel.

H. Round Duct Fitting Fabrication:

1. Ductwork and fittings shall be by the same manufacturer.
2. Circumferential and longitudinal seams of all fittings shall be a continuous weld or spot welded and sealed with mastic. All welds shall be painted to prevent corrosion.
3. 90-degree Tees and Laterals and Conical Tees: Fabricate to conform to SMACNA 2005 Figures 3-5 and 3-6 and with metal thicknesses specified for longitudinal seam straight duct. Where bullhead tees are provided, they shall be Semco type BHT, BHT-1R, or BHT-2R with turning vanes or approved equal.
4. Diverging-Flow Fittings: Fabricate with entrance to branch taps with no excess material projecting from the body onto branch tap entrance. No burrs or rough welds will be allowed.
5. Elbows: Fabricate with die-formed, pleated, segmented (welded) or adjustable gore construction. Fabricate the bend radius of die-formed, segmented and pleated elbows 1.5 times the elbow diameter. Fabricate the bend radius of adjustable gore elbows 1.0 times the elbow diameter. Unless elbow construction type is indicated, provide elbows meeting the following requirements.

a. Segmented Elbows:

1) Fabricate mitered elbows with continuous welded construction in gauges specified below.
2) Elbows Radius and Number of Pieces: Unless otherwise indicated, construct elbow to comply with SMACNA 2005 Table 3-1.
3) **Elbows - Gauges:** Provide minimum metal thickness listed below for pressure classes shown:

<table>
<thead>
<tr>
<th>Pressure Class Range Size</th>
<th>2 to 2”</th>
<th>&gt;2” to 10”</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 to 14 inches</td>
<td>24 gauge</td>
<td>24 gauge</td>
</tr>
<tr>
<td>15 to 26 inches</td>
<td>24 gauge</td>
<td>22 gauge</td>
</tr>
<tr>
<td>27 to 36 inches</td>
<td>22 gauge</td>
<td>20 gauge</td>
</tr>
<tr>
<td>37 to 50 inches</td>
<td>20 gauge</td>
<td>20 gauge</td>
</tr>
<tr>
<td>52 to 60 inches</td>
<td>18 gauge</td>
<td>18 gauge</td>
</tr>
<tr>
<td>62 to 84 inches</td>
<td>16 gauge</td>
<td>16 gauge</td>
</tr>
</tbody>
</table>

b. **90-Degree, 2-Piece, Mitered Elbows:** Use only for supply systems, or exhaust systems for material handling classes A and B; and only where space restrictions do not permit the use of 1.5 bend radius elbows. Fabricate with single-thickness turning vanes. Equal to Semco model 902V. Elbows shall have a minimum number of vanes in accordance with the following:

<table>
<thead>
<tr>
<th>Duct Diameter</th>
<th>Number of Vanes</th>
</tr>
</thead>
<tbody>
<tr>
<td>3” thru 9”</td>
<td>2</td>
</tr>
<tr>
<td>10” thru 20”</td>
<td>3</td>
</tr>
<tr>
<td>21” and up</td>
<td>5</td>
</tr>
</tbody>
</table>

c. For supply duct runouts to air devices only at maximum 2 inch pressure class, 24 gauge galvanized steel, Adjustable (Gored) Elbows with minimum 4 piece construction, and maximum 18” diameter may be used. Seal all joints.

d. **For Pressure Class above 2 inch.**

1) **Round Elbows - 8 Inches and smaller shall be die-formed elbows for 45-and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only.** Fabricate nonstandard bend angle configurations or 1/2-inch-diameter (e.g. 3½ and 4½ inch) elbows with segmented construction. Die-Formed Elbows shall be 20 gauge with 2-piece continuous welded construction. Pleated Elbows shall be 26 gauge.

2) **Round Elbows - 9 Through 14 Inches shall be segmented or pleated elbows for 30, 45, 60, and 90 degrees, except where space restrictions require a 2 piece mitered elbow.** Fabricate nonstandard bend angle configurations or ½ inch-diameter (e.g. 9½ and 10½ inch) elbows with gored construction. Pleated Elbows shall be 26 gauge. Segmented elbows shall be as indicated in the next paragraph.

3) **Round Elbows - 9 inches and Larger shall be segmented elbows with continuous welded construction, except where space restrictions require a 2 piece mitered elbow.**

6. **Couplings:** Slip-joint construction per SMACNA 2005 Figure 3-2, detail RT-1 with a minimum of a 2-inch insertion length.

7. **PVC-Coated Elbows and Fittings:** Fabricate elbows and fittings as follows:
2.4 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts, powder actuated fasteners, or structural steel fasteners appropriate for building materials and local authority having jurisdiction.

1. Powder actuated fasteners shall not be allowed where the piping, ductwork or equipment is required to meet seismic bracing requirements in Section 230020 or the Building Code and unless the powder actuated fasteners are rated for these seismic loads. Powder actuated fasteners shall not be allowed in tension applications for Seismic Design Category D, E or F (as defined by the International Building Code).

2. Do not use powder actuated concrete fasteners unless approved by the Engineer in writing.

B. Hangers and support components shall be factory fabricated of materials, design, and manufacturer complying with MSS SP-58 and MSS SP-69 except as modified herein.

C. Upper attachments shall be as indicated in SMACNA 2005 Figures 5-1 through 5-4.

1. C-Clamps: Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

2. Structural Attachments shall be B-Line, Unistrut, Grinnel, or approved equal:

   - Beam clamps: B 3031, B 3033, B 3034, B 3050, B 3045
   - Angle Iron Beam Clamp: B 3046
   - Bar Joist: B 3059
   - Concrete Inserts: B 3500, B 2505 thru 2508, or B 3014
   - Drilled Inserts: Phillips Red-head, wedge anchors or equal.

D. Hangers:

1. Strap and band hangers shall be fabricated of the same material as the sheet metal ducts.

2. Hanger sizes shall be as indicated in SMACNA 2005 Tables 5-1 and 5-2 for sheet steel width and gauge and steel rod diameters.

3. Rod hangers shall be fabricated of round, cadmium-plated threaded steel rods and nuts.

   a. Rod hangers Installed in Corrosive Atmospheres: Electro-galvanized, all-thread rod or hot-dipped-galvanized rods with threads painted after installation.

   b. Hanger rods shall be threaded both ends, threaded one end, or continuously threaded.
4. Seismic sway bracing shall be in accordance with Section 230020.
   b. Steel Cables for Stainless-Steel or Aluminum Ducts: Stainless steel complying with ASTM A 492.
   c. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

E. Lower Attachments:
   1. Duct attachments shall be sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
   2. Lower attachment shall be as indicated in SMACNA 2005 Figure 5-5.

F. Trapeze and Riser Supports:
   1. Trapeze sizes shall be as indicated in SMACNA 2005 Tables 5-3 and 5-4 and Figure 5-6 and 5-8 through 5-10.
   2. Where trapeze or riser supports are a different material than the sheet metal duct, a minimum 1/16 inch thick isolation gasket shall be provided between the duct and the support.

2.5 FLEXIBLE ROUND DUCT

A. Low Pressure Flexible duct shall be UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire coated to prevent corrosion; fiberglass insulation; and fiberglass reinforced aluminized vapor-barrier film and shall be used for systems up to 2" static pressure class.
   1. Insulated, Flexible Duct: round duct shall be Thermaflex M-KM or by Flexmaster, Flexible Technologies, ATCO, or Quietflex.
   2. Factory installed insulation shall be min. 3/4 pound density 1-1/2" thick, minimum R-4.2.
   3. Exterior vapor barrier shall have maximum vapor barrier permeance of 0.05 perm per ASTM Method E96, Procedure A
   4. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
   5. Rated Air Velocity (or higher): 4000 fpm.
   6. Temperature Range: Minus 20 to plus 175 deg F.

2.6 FLEXIBLE CONNECTORS

A. Flexible connectors installed inside the building shall be heavy glass fabric, double coated with neoprene, of approximately 30 oz. per square yard, provided with 3" wide, 24 ga. metal mounting strips firmly attached to each edge. Connectors shall be suitable for pressure class of the air handling system. Flexible connectors shall be "Ventfab" by Ventfabrics, Inc. or equal.

B. Flexible connectors installed outside the building shall be heavy glass fabric, double coated with neoprene, of approximately 26 oz. per square yard, provided with 3" wide, 24 ga. metal mounting strips firmly attached to each edge. Connectors shall be suitable for pressure class
of the air handling system. Flexible connectors shall Ventlong Hypalon by Ventfabrics, Inc. or equal.

2.7 DUCT LINER

A. Fiber Glass Duct Liner shall comply with ASTM C 1071, NAIMA AH124, "Fibrous Glass Duct Liner Standard, and NFPA Standard 90A.

B. Materials: ASTM C 1071, Type I, with an anti-microbial, coated surface exposed to airstream to prevent erosion of glass fibers.

C. Thickness & Density: See Shop Application of Liner in Rectangular Ducts under Part 3 below.

<table>
<thead>
<tr>
<th>Normal Thickness, in.</th>
<th>Density, pcf</th>
<th>R-Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2</td>
<td>1.5</td>
<td>2.2</td>
</tr>
<tr>
<td>1</td>
<td>1.5</td>
<td>4.2</td>
</tr>
<tr>
<td>1-1/2</td>
<td>1.5</td>
<td>6.0</td>
</tr>
<tr>
<td>2</td>
<td>1.5</td>
<td>8.0</td>
</tr>
<tr>
<td>1-1/2</td>
<td>3.0</td>
<td>6.5</td>
</tr>
<tr>
<td>2</td>
<td>3.0</td>
<td>8.7</td>
</tr>
</tbody>
</table>

D. Thermal Performance: Provide minimum "R-Value" indicated above, at a mean temperature of 75°F.

E. Liner, including coatings and adhesives shall have a flame spread of 25 or less and a smoke developed rating of 50 or less as determined in accordance with ASTM Standard E84.

F. Liner Adhesive shall be a water-based adhesive complying with NFPA 90A or NFPA 90B and with ASTM C 916. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24). Operational temperature range -20 to +160°F; curing time 24 hours. Adhesive 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."

1. Adhesive shall be Benjamin Foster 85-60, United McGill, type Uni-Tack or approved equal.

G. All exposed edges and the leading edge of all cross joints of the liner shall be sealed to prevent glass fibers from separating and entering the airstream. Sealer shall be Benjamin Foster 30-36 or approved equal.

H. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct. Provide fasteners that do not damage the liner when applied as recommended by the manufacturer, that do not cause leakage in the duct, and will indefinitely sustain a 50-pound tensile dead load test perpendicular to the duct wall.
1. Fastener Pin Length: As required for thickness of insulation, and without projecting more than $\frac{3}{4}$ inch into the airstream.
2. Adhesive for Attachment of Mechanical Fasteners: Comply with the "Fire Hazard Classification" of duct liner system.

I. The duct liner shall have a surface roughness that gives an Air Friction Correction Factor not greater than 1.2 at velocities of 4000 FPM.

J. The liner shall have the following Noise Reduction Coefficients Frequency:

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>125</td>
<td>.23</td>
</tr>
<tr>
<td>250</td>
<td>.54</td>
</tr>
<tr>
<td>500</td>
<td>.68</td>
</tr>
</tbody>
</table>

K. The duct liner shall Owens Fiberglass Quiet R Rotary Duct Board or equal by Knauff, Manville, Certain Teed or equal.

2.8 External Duct Insulation: See Section 230200 - Mechanical Insulation.

2.9 AIR DEVICES

A. Model numbers for air devices are given in the Air Device Schedule. The model numbers and manufacturers listed are given to establish the desired style, quality, and performance. Products by the following manufacturers, equal to those scheduled and complying with these specifications, are equally acceptable.

1. Titus
2. Krueger
3. Nailor
4. Price
5. Tuttle & Bailey
6. Metal Aire

B. Diffuser and return air grille sizes given on the plans are neck sizes. Grille sizes are core sizes.

C. Air devices shall have an NC rating of NC30 or less at specified CFM.

D. Air devices shall be sized to match the ceiling grid. Furnish air devices for either regular grid ceilings or for narrow grid ceilings or for both types of grid; coordinate with the architectural reflected ceiling plans.

E. Air device finishes shall be as follows:

1. Ceiling mounted - Flat White
2. Wall mounted - Flat White, verify with Architect
3. Floor mounted - Shall be coordinated with Architect
4. Duct mounted - Light grey prime coat on steel materials and natural non-oxidizing finish on aluminum
5. Opposed blade dampers - Black
6. Other as called for in the Schedule
F. A sponge rubber gasket shall be provided on back side edge of all mounting frames to provide a snug tight fit to construction surfaces.

G. Where round ductwork is used, provide a square-to-round adapter with the air device.

H. Slot diffusers shall comply with the following:
   1. Diffuser shall include a factory fabricated plenum of minimum 26 gauge galvanized steel.
   2. Inside of plenum shall be internally insulated with 1/2" duct liner. Liner shall meet specifications for duct liner indicated above.
      a. Portions of plenum not factory insulated shall be externally insulated with 1 ½", 1lb duct wrap per specification 230200.(specifically end caps)
   3. Plenum shall include an inlet collar for flexible round duct. Inlet shall include a balance damper.

I. Linear Bar diffusers shall comply with the following:
   1. Diffuser shall include a field fabricated plenum of minimum 26 gauge galvanized steel.
   2. Inside of plenum shall be painted flat black.
   3. Plenum shall include inlet collar(s) for flexible round duct as indicated. Inlets shall include a balance damper.

J. The air outlets in surgery shall be laminar type air distribution. Air panels shall include the following:
   1. Face plates shall be perforated, stainless steel, removable, and shall be retained in place with quarter turn fasteners. Face plate shall have vinyl coated, stainless steel safety retainers.
   2. Plenum and remainder of air panel shall be aluminum construction.
   3. Air panels shall include a balancing damper in the neck of the upper plenum.
   4. The upper plenum shall have control mechanism to meter the air flow through air diffusion devices into the lower plenum. The air shall then flow through the perforated face plate.
   5. During operation, there shall be zero aspiration at the face plate and velocities shall vary no more than 10%.

2.10 FIRE DAMPERS

A. General
   1. Fire dampers in ducts connected to a fan shall be the UL labeled, dynamic rated fire dampers unless otherwise indicated on the plans. Fire dampers in transfer ducts not connected to a fan shall be the UL labeled, static rated fire dampers unless otherwise indicated on the plans. Dampers shall be the curtain type, except where the size is too large they shall be multi-blade type, unless otherwise indicated on the drawings.
2. Fire dampers shall be constructed and tested in accordance with UL Standard 555. Each damper shall have a 165 degrees F fusible link (see plans for dampers with link rating of 212 or 280 degrees F).

3. Dampers shall have Ductmate breakaway connections where either the height or width of the connecting duct is 48” or greater.

4. When the wall or floor opening exceeds the dampers maximum UL listed multiple section assembly size, provide mullions manufactured by the damper manufacturer where so approved by their UL rating.

5. Provide factory installed sleeves for fire dampers. Sleeves shall be the same thickness as the adjacent duct, or the minimum thickness required by governing code, but not less than the following:

<table>
<thead>
<tr>
<th>Max. Long Side of Duct or Diameter</th>
<th>Steel Gauge</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-12 inches</td>
<td>26</td>
</tr>
<tr>
<td>13-30 inches</td>
<td>24</td>
</tr>
<tr>
<td>31-54 inches</td>
<td>22</td>
</tr>
<tr>
<td>55-84 inches</td>
<td>20</td>
</tr>
<tr>
<td>85 inches and above</td>
<td>18</td>
</tr>
</tbody>
</table>

6. Provide access doors to allow resetting of fire damper and replacement of the link.

7. Fire dampers shall be manufactured by Ruskin, Air Balance, Pacific, Phillips, Prefco, Nailor, Greenheck, or Airstream.

B. Curtain Type Fire Dampers

1. Curtain type fire dampers shall be type B (type C for round ducts) unless otherwise indicated on the drawings.

2. Curtain type dampers shall be gravity operated for vertical installations; dampers in a horizontal position shall have stainless steel closure spring and blade lock. Fire dampers shall be equipped for vertical or horizontal installation as required by the location indicated.

3. Curtain type fire damper pressure drop shall not exceed the following:

<table>
<thead>
<tr>
<th>VEL (FPM)</th>
<th>P.D. (W.C.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>0.01</td>
</tr>
<tr>
<td>1500</td>
<td>0.015</td>
</tr>
<tr>
<td>2000</td>
<td>0.07</td>
</tr>
<tr>
<td>3000</td>
<td>0.15</td>
</tr>
</tbody>
</table>

C. Multi Blade Fire Dampers

1. Type A (type C for round ducts) unless otherwise indicated on the drawings.

2. Stainless steel closure spring and blade lock.

3. Equipped for vertical or horizontal installation as required by the location indicated.

4. Dynamically rated to close at 4,000 fpm and 4” differential static pressure.
5. Galvanized steel construction, except where otherwise indicated.
6. Blades: Airfoil design, double skin 16 gauge (14 gauge equivalent), max. 6-1/4" wide.
7. Frames: 16 gauge, 5" x 7/8" hat channel with reinforced corners.
9. Provide factory installed jack-shaft with spring closer. Linkage shall be concealed in frame.
10. Multi Blade fire damper pressure drop shall not exceed the following:

<table>
<thead>
<tr>
<th>VEL (FPM)</th>
<th>P.D. (W.C.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>0.02</td>
</tr>
<tr>
<td>1500</td>
<td>0.04</td>
</tr>
<tr>
<td>2000</td>
<td>0.07</td>
</tr>
<tr>
<td>3000</td>
<td>0.15</td>
</tr>
</tbody>
</table>

D. Curtain type dampers shall be Ruskin model DIBD2 (1-1/2 hour) and DIBD23 (3 hour) for dynamic type and IBD2 (1-1/2 hour) and IBD23 (3 hour) for static type unless otherwise indicated on the plans. Multi-blade type dampers shall be Ruskin model FD-60 (1-1/2 hour) and FD-31 (3 hour) unless otherwise indicated on the plans.

E. Ceiling Fire dampers shall be Ruskin Model CFD4W, and CFD(R) 3.5 W for passing through rated ceilings in wood construction. Provide insulation blanket for ceiling fire dampers.

2.11 MOTORIZED DAMPERS

A. Motorized Dampers shall be:

1. Rated per AMCA standard 500: Pressure drop rated in accordance with figure 5.3; leakage rated in accordance figure 5.5.
2. Rated for up to 180 degrees F.
3. 1/2" diameter x 2" long axles, cadmium plated steel (or hex or square).
4. Stainless steel axle bushings.
5. Blades securely attached to shaft.
6. Linkage shall be concealed in frame and shall be plated steel bars with stainless steel pivots.
7. Maximum pressure drop shall be rated for a 24"x24" test duct.

B. Type A Motorized Dampers shall be equal to Ruskin CD-60 with the following features: Nailor 1120, American Warming VC-27 or approved equal by Arrow, Penn, or Greenheck shall be equally acceptable.

1. Opposed blades.
2. Allowable velocity of 3000 FPM (48"- 60" long blades) and 4000FPM (max. 48" long blades) and differential pressure of 3.5" W.G.
3. Frame - 5" x 1" x 16 gauge galvanized steel hat channel.
4. Blades - Airfoil shaped, double skin galvanized steel construction of 14 gauge equivalent thickness, maximum 6" wide. Blade extensions may be used on top and/or bottom blades to meet damper size requirements without diminishing free area.
5. Seals - Extruded vinyl blade edge seals and flexible metal compressible jamb seals.
7. Maximum pressure drop at 3000 fpm shall not exceed 0.30" W.G.
8. Damper torque requirements shall not exceed 5 in-lbs per ft. for opposed blade
dampers and 7 in-lbs per ft. for parallel blade dampers.
9. Maximum Leakage per Sq.Ft. at 1" W.G. differential pressure: 3.0 CFM for dampers 12"
to 24" wide and 2.0 CFM for dampers greater than 24" wide.
10. Maximum single dampers section shall be 60" wide x 72" high.
11. For multiple section dampers, each section shall be operated by a separate actuator.
12. Mount actuators directly to a ½" diameter control shaft with outboard support bearing
that extends 6" beyond the damper frame.

C. Motorized damper actuators shall have the following features.
   1. Actuators shall be Belimo model AF24-SR or equivalent by Siemens or Siebe. No other
      substitutions allowed.
   2. Actuators shall be connected to the dampers as shown in details on the drawings.
      Provide all needed linkages and materials for a complete operating damper.
   3. Actuators shall be factory mounted and connected to the damper section(s).
   4. Size all actuators for minimum of 130% of the torque required to operate the damper(s).
   5. Maximum time for full stroke or return of 135 seconds. The spring return running time
      shall be approximately 40 seconds.
   6. Each actuator shall have a minimum torque of 133 in-lbs.
   7. The actuator shall have spring return for fail-safe operation. During normal operation
      the actuator shall not work against the force of the spring.
   8. The actuator shall be powered by either 24 VAC or 24 VDC. Power consumption shall
      not exceed 6 watts. Actuator control shall be proportional by a 0 to 10 VDC or 4 to
      20mA signal, with the addition of a 500 ohm resistor.
   9. Provide a conduit connection for actuators located in mechanical rooms or outdoors
      and a 1 foot long plenum rated cable for connection to a junction box for actuators
      located in ceiling plenums.
10. Actuator shall have built-in overload protection to prevent damage to the actuator when
    the actuator or damper reaches its end position. End switches are not acceptable.
11. Actuator shall be UL listed and labeled.
12. Actuator shall be designed for a minimum 60,000 open-close cycles and 1000 spring
    return cycles.

2.12 BALANCE DAMPERS

A. General
   1. All balance dampers occurring in concealed ductwork, except those above removable
      ceilings, shall be installed with shafts vertical.
   2. Provide control rod extending beyond the duct with a single locking quadrant for all
      volume dampers. Locking quadrant shall be continuously adjustable throughout a 90
      degree operating range.
   3. For dampers in ducts with liner, provide hat channel to match liner thickness; for
      dampers in ducts with external insulation, provide hat channel under locking quadrant
      same thickness as insulation.
   4. Blade extensions may be used on top and/or bottom blades of Multi-blade dampers to
      meet damper size requirements without diminishing free area. Multi-blade dampers
shall have opposed blades and shall be tested in accordance with AMCA standard 500, figure 5.3.

B. Single Blade Dampers shall be allowed in ducts up to 2.25 sq. ft.

1. Single Blade Dampers shall have 16 gauge galvanized steel or 0.090" aluminum reinforced blades, 16 gauge galvanized steel or 0.090" aluminum frames, 1/2" diameter (or hex or square) shafts that are minimum 2" long, and nylon or bronze axle bushings. Securely attach blades to shaft. Dampers shall be rated for up to 1,500 fpm and 1" differential static pressure. Provide volume dampers integral with "spin-in" where appropriate or indicated. Single blade dampers shall be Vent Products model 5101 (rectangular), model 5301 (round), or approved equal by Ruskin, Nailor, or American Warming.

2. Alternate Single Blade damper Construction: Similar construction to above except blade and shaft may be shop fabricated and mounted in duct (or spin-in) without a separate damper "frame." Provide shaft continuously through duct with locking quadrant on one end and end bearing on other end. End bearing shall be Young Regulator No. 656 or approved equal.

C. Where dampers occur in non-accessible space, such as above plaster ceilings, or within chases, extend damper rod to recessed cup with flush cover plate in the ceiling. Young Regulator #301, or equal. Alternately, provide rack and pinion controller with flexible wire connector to operate damper up to 50 feet away; provide all needed hardware at damper and remote location; provide 6 wrenches to Owner; for ceiling, wall or plenum mounting or as indicated on the plans; equal to Young Regulator Bowden Cable Controllers 270.

2.13 BACK DRAFT DAMPERS

A. Back draft dampers shall comply with the following:

1. Shall have minimum 2", 0.125" thick extruded aluminum frame reinforced for rigidity.
2. Aluminum blades of maximum 6" width.
3. Adjustable counterweight.
4. Cadmium plated steel shafts.
5. Blade shafts shall operate in ball bearings.
6. Hardware shall be cadmium plated steel with brass pins.
7. Dampers shall include blade edge seals. Leakage shall be less than 12 cfm per sq. ft. at ½ inch W.G.
8. Use multiple damper sections for sizes above 48" x 48".

B. Back draft dampers shall be Ruskin model BD-6 or approved equal by NCA, Greenheck, or Nailor.

2.14 ACCESS DOORS

A. Access doors for ductwork shall be minimum 22 gauge galvanized steel with a continuous piano type hinge and camlock(s) (1 for doors 16" and 2 for larger doors); air leakage shall not exceed 0.21 CFM per square foot at 1 inch static pressure. Doors shall be 24" x 24", except for small ducts, where doors shall be as large as practical. Doors shall include a seal between the
door and frame and shall also include a seal between the frame and duct. Doors shall be Ruskin model ADH 12 or equal by Cesco Products (Minneapolis, Mn.), A.J Manufacturing, or approved equal.

2.15 LOUVERS

A. The scheduled Ruskin louver selection is to establish the desired style, quality, type and performance. Equal products by NCA, Nailor, Vent Products, Air Balance, or Greenheck are acceptable.

B. Louvers shall be constructed of aluminum with an anodized aluminum finish and shall include a matching sill extension.

C. Blades shall be minimum 0.08” extruded aluminum and shall be 4” storm-proof design.

D. Louvers shall bear the AMCA certified rating seal for air performance and water penetration.

E. Water penetration shall not exceed 0.01 oz. of water per ft² in 15 minutes when tested in compliance with the standard described above at a free area velocity of 500 fpm.

F. Maximum pressure drop shall not exceed 0.035” w.c. at a free area velocity of 500 fpm. Pressure drop rating shall include the birdscreen.

G. Louver shall include ½” x ½” mesh 0.063” aluminum birdscreen.

2.16 EXPOSED-FASTENER, LAP-SEAM METAL ROOF- WALL PANELS

A. Box-Rib-Profile, Exposed-Fastener Metal Roof Panels “B-Deck”: Formed with raised, box-shaped ribs that are wider than recesses, evenly spaced across panel width, and with rib/recess sides angled more than 60 degrees. Formed with ribs at 6 inches o.c. across width of panel and 1-1/2 inch deep x 2-1/2 inch wide recesses.

1. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
   a. MBCI; Div. of NCI Building Systems - B-Deck.

2. Material: Zinc-coated (galvanized) steel sheet, nominal 0.052 inch (18 gauge) thickness.
   b. Color: As selected by Architect from manufacturer's standard colors.

3. Manufacturer’s standard width is 36 inches and lengths ranging from 8 feet to 12 feet. Pieces can be cut to size.

4. Joint Sealant: ASTM C 920; elastomeric polyurethane, polysulfide, or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal roof panels and remain weathertight; and as recommended in writing by metal panel manufacturer.

5. Panel Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with
heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM, PVC, or neoprene sealing washers.

2.17 LOUVERS (BRICK VENT)

A. Manufacturers:
   1. Greenheck
   2. Ruskin

B. Louvers performance shall be AMCA Certified and shall meet or exceed the following specifications:
   1. Static pressure drop: 0.10" or less at 1000 FPM through free area.
   2. Minimum Free Area: 22% minimum.

C. Type: 4 inch (100 mm) deep with blades on 45 degree slope, drainable, heavy channel frame, insect screen with 18 in x 14 in aluminum mesh.

D. Fabrication: 0.125" thick extruded aluminum, factory baked enamel finish, color as selected by Architect.

PART 3 - EXECUTION

3.1 HANGING AND SUPPORTING DUCT WORK

A. All ductwork shall be neatly supported and properly anchored to building construction so horizontal ducts are without sag or sway, vertical are without buckle and all are free from the possibility of deformation collapse or vibration.

B. Install rigid round, rectangular, and flat oval metal duct with support systems indicated in SMACNA 2005 Tables 4-1 through 4-3 and Figures 4-1 through 4-9.

C. Install single wall ductwork except where double wall ducts are indicated on the plans.

D. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection. Provide trapeze hanger diagonally under all elbows greater than 54 inches wide.

E. Support vertical ducts at a maximum interval of 16 feet and at each floor.

F. Upper attachments to structures shall have an allowable load not exceeding 1/4 of the failure (proof test) load.

G. Hanger rods shall have double nuts and lock washers at all connections.

H. Install concrete inserts prior to placing concrete.

I. Install drilled inserts and powder actuated concrete fasteners after concrete is placed and completely cured. Obtain approval of the Engineer prior to using powder actuated concrete fasteners.

J. Duct shall not be supported from metal roof deck.
3.2 DUCT INSTALLATION, GENERAL

A. Duct System Pressure Class: Construct and install each duct system for the specific duct pressure classification indicated.

B. Verify exact locations and space requirements of ducts at the site and coordinate work with other trades, before fabricating ductwork.

C. Install ducts with the fewest possible joints.

D. Use fabricated fittings for all changes in directions, changes in size and shape, and connections. Provide all drops, raises, transitions, or offsets as required, at no additional cost to the Owner, Architect or Engineer, due to obstructions. When additional offsets, etc., different from those shown are required, approval shall be obtained from the Engineer prior to proceeding. All size or shape transitions shall be made gradually with angle not to exceed 15 degrees on each side.

E. Install branch take-offs tight to duct wall with projections into main duct kept to a minimum. Ragged edges projecting into the main duct shall not be allowed.

F. Locate ducts, except as otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install duct systems in shortest route that does not obstruct usable space or block access for servicing building and its equipment.

G. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities. The sheet metal work shall be coordinated with that of other trades in such a manner that when the installation is complete, all items are properly installed and are serviceable.

H. Install insulated ducts with 1-inch clearance outside of insulation.

I. Conceal ducts from view in finished and occupied spaces by locating in mechanical shafts, hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown.

J. Coordinate layout with ceiling, lighting layouts, sprinklers and other piping.

K. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

L. Non-Fire-Rated Partition Penetrations: Where ducts pass interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with escutcheon of sheet metal flanges of same gauge as duct. Overlap opening on 4 sides by at least 2 inches.

M. Branch Connections: Comply with SMACNA 2005 Figures 4-5 and 4-6.

1. Install radius elbows and vaned elbows where shown on the plans. Radius elbows may be substituted for vaned elbows, but vaned elbows shall not be substituted for radius type unless approved in writing by the Engineer. 45 degree taps and other taps shall not be substituted for elbows.
N. Outlet and Inlet Connections: Comply with SMACNA 2005 Figures 7-6, 7-7 and 10-1 and as indicated on plans.

O. Flexible Connections at Fans: Comply with SMACNA 2005 Figure 7-8.

P. Provide openings in ductwork where required to accommodate thermometers and temperature sensors.

Q. Clean duct system and force high velocity air through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with filters, or bypass during cleaning.

R. During construction all open ends of installed ductwork shall be kept covered to prevent dirt and debris from entering ducts. Openings shall be covered with plastic sheeting held in place with duct tape. Any ducts stored on site shall be protected by keeping them raised off the ground.

S. Ducts shall be neatly finished on the outside with all sharp edges removed. Inside surfaces shall be smooth with no projections into the air stream.

T. All fasteners and attachments shall be made of the same material as the ducts or of corrosion-resistant material.

U. Ducts up through 2" pressure class shall have all transverse duct joints sealed in compliance with the sealant manufacturer's recommendations and SMACNA procedures for Seal Class C. Ducts over 2" pressure class shall have transverse and longitudinal joints sealed in compliance with the sealant manufacturer's recommendations and SMACNA procedures for Seal Class A.

V. Duct accessories exposed to the air stream, such as dampers of all types (except smoke dampers) and access openings, shall be of the same material as the duct or provide at least the same level of corrosion resistance. Dissimilar metals shall be connected with flanged joints made up with neoprene gaskets to prevent contact between metals. Flanges shall be fastened with bolts protected by ferrules and washers made of the same material as the gaskets.

W. Where dampers are installed in ducts having external duct insulation, install damper locking quadrants with hat channel or of same depth as insulation to allow smooth operation of dampers.

X. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

3.3 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Provide hanging materials that match the appearance of the exposed ducts.

C. Remove any identification labels or markings from ducts so appearance of ducts at such locations matches the remainder of the ducts.
D. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

E. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

F. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

G. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.4 INSTALLATION OF EXHAUST DUCTS FOR KITCHEN HOODS

A. All joints and seams shall be continuously welded.

B. Joints in aluminum ducts shall be welded and shall be ground smooth to achieve a finished appearance.

C. Metal gauges shall be increased from minimums lists as required to allow welding.

3.5 INSTALLATION OF DRYER EXHAUST DUCT

A. Dryer duct shall not have any fasteners within air stream. Interior of duct shall be smooth, free of any possible lint catching ridges and with push fittings in direction of airflow.

B. Install Dryer-ell 90 degree elbows and dryer-ell 45 degree elbows where needed to meet maximum dryer vent distance requirements.

3.6 LEAKAGE TESTING

A. Ducts, plenums, and casings shall be tested and made substantially airtight at static pressure indicated for the system before covering with insulation or concealing in masonry. The term, "substantially airtight," shall be construed to mean that no air leakage is noticeable through the senses of feeling or hearing.

3.7 DUCT CLEANING

A. Clean new duct system(s) to remove oil film and dust before testing, adjusting, and balancing.

B. See Section 230901, “Duct Cleaning” for additional requirements.

3.8 SEISMIC RESTRAINT INSTALLATION

A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces. Comply with requirements of Section 230020, Vibration and Seismic Controls for HVAC Piping and Equipment.

B. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c. unless otherwise indicated.
C. Brace a change of direction longer than 12 feet.

D. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

E. Install cables so they do not bend across edges of adjacent equipment or building structure.

F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

G. Drilling for and Setting Anchors:
   1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
   2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
   3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
   4. Set anchors to manufacturer’s recommended torque, using a torque wrench.
   5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.9 FLEXIBLE ROUND DUCT INSTALLATION

A. Application
   1. Flexible round ductwork may be used where shown on the drawings.
   2. Provide low pressure flex ducts in ducts rated 2" static pressure class or less.
   3. Provide high pressure flex ducts in ducts rated over 2" static pressure class.
   4. Flexible duct shall not pass thru any wall, floor or ceiling.

B. Slide vapor barrier and insulation away from ends. Secure flex duct to diffusers and main duct takeoff with flame retardant nylon or stainless steel draw bands. Slide vapor barrier and insulation back over flex duct and secure in place with draw band or duct tape. Apply duct sealer if necessary to obtain a leak tight connection. Nylon cable ties shall be 0.19 inch width minimum, with standard cross-section and shall comply with UL-181 or UL - 2043.

C. All flexible duct shall be routed and supported in such a manner that the duct is not flattened in any area and that full cross sectional area is maintained. All bends shall be made in such a manner that the ratio of the center line radius of the bend to the inside diameter of the duct is not less than 1. Support flexible ducts from building structures in accordance with SMACNA 2005 Figure 3-10 or 3-11. Provide a sheet metal saddle between the insulation and strap, to prevent duct from sagging excessively and from resting on lights, ceilings, etc.

D. Where flex duct turns 90°, provide a 90° sheet metal elbow or support the flex duct through the turn with a “Flex Flow Elbow” by Thermaflex or equal.
E. All bends shall be made so that the ratio of the center line radius of the bend to the inside diameter of the duct is not less than 3.

F. Maximum length of flexible ducts shall be 8 feet unless otherwise indicated.

3.10 FLEXIBLE CONNECTOR INSTALLATION

A. Flexible connectors shall be provided where fans, air handling units, fan terminal units, fan coil units, and rooftop units connect to ducts or casings to prevent transmission or vibration to ductwork.

B. Flexible connectors shall fit tightly around ducts and fans and shall be securely bolted in place.

C. Joints between flexible connectors and duct or fan shall be sealed with duct sealer.

3.11 FIRE DAMPER INSTALLATION

A. Damper installation shall be in compliance with NFPA #90A, UL requirements and manufacturer's installation instructions.

B. Fire dampers shall be installed in all ducts and openings through fire rated partitions, ceilings and floors, where required by Code, and where indicated on plans.

C. Minimum fire damper width shall be 12" unless otherwise indicated. Provide duct transition if necessary to achieve the minimum width. Provide an access door in the duct and/or an access panel in the wall or ceiling to allow resetting the damper. All dampers must be installed so the fusible link is accessible.

D. Provide 1-1/2 and 3 hour rated fire dampers at locations shown on the drawings or as required by governing codes.

3.12 BALANCE DAMPER INSTALLATION

A. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts. Install minimum 2 duct widths from duct take-off. Provide balance dampers where shown or where required to properly balance and direct air flow.

B. Every supply air outlet shall have a balance damper at the branch duct takeoff to the supply outlet regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

C. Exhaust grilles shall have a balance damper at the branch duct connection to the main duct.

D. Install damper control devices on stand-offs where required to allow complete coverage of insulation.

3.13 LOUVER INSTALLATION

A. Install louver and sill extension in building opening where indicated. Secure louver to structure in accordance with manufacturer’s instructions.

B. Seal between louver and building opening to prevent moisture entry.
C. Connect ducts to louvers, plenums, and casings and seal to prevent leakage.
D. Provide drain in ducts, plenums, and casings to allow moisture that bypasses the louver to be removed.

3.14 BACK DRAFT DAMPER INSTALLATION
A. Back draft dampers shall be installed on exhaust fans where scheduled and other locations where indicated on drawings.

3.15 MOTORIZED DAMPER INSTALLATION
A. Coordinate with Section 230960 for actuator requirements.
B. Install motorized dampers per manufacturer's instructions.
C. Actuators shall be installed on the outside of ducts unless otherwise indicated. Provide access doors where damper motors are concealed in ducts.
D. Install damper control devices on stand-offs where required to allow complete coverage of insulation.

3.16 ACCESS DOOR INSTALLATION
A. Provide access doors in ducts at fire dampers, where actuators for motorized dampers are concealed inside ducts, and at other items located in ducts or plenums where access into ductwork is required for maintenance or installation of work by other trades.

3.17 TEST OPENING INSTALLATION
A. Provide test openings in ductwork for testing and balancing.
B. Patch insulation, ductwork, and housings, using materials identical to those removed.
C. "Plastic Plugs" may be used to seal openings where duct traverses are made.
D. Provide Pitot tube openings where required for testing of systems. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

3.18 INSTALLATION OF DUCT SMOKE DETECTORS
A. Install duct detectors furnished in Section 260721 or Section 230960 per manufacturer's instructions in ductwork or air handling units where indicated. Where a duct is not wide or high enough for the smoke detector to be installed, provide a transition in the duct to allow the smoke detector installation.

3.19 INSTALLATION OF DUCT MOUNTED CO2 SENSORS
A. Install duct mounted CO2 sensors furnished in Section 230960 in ductwork or air handling units where indicated per manufacturer's instructions.

3.20 AIR DEVICE INSTALLATION
A. Air direction patterns shall comply with those shown and adjustments shall be made to prevent impingement of moving air on walls. Coordinate locations of outlets and inlets with other contractors to avoid interferences and to effect proper installation. Outlets in lay-in ceilings shall be located as close to positions shown on plans as the ceiling grid will allow; notify Architect and Engineer before proceeding if ceiling grid will not allow layout shown.

B. Diffusers and grille layouts shown on the plans have been coordinated with the layout of the ceiling grid to establish the desired arrangement of grilles and diffusers. Prior to installing any ductwork which would be affected by the grid layout, verify the grid layout with the Architectural ceiling plans and the actual ceiling layout.

C. Provide a square-to-round or round-to-square adapter with the air device where necessary to connect to the ductwork shown.

D. Fasten air device frames and borders to drywall ceilings and walls where required. Provide a plaster ring to allow lay-in style devices to be used for drywall installations.

E. Clean construction dirt from all air devices.

F. Provide extension duct collar from ductwork to air devices connected to rigid duct. Fasten with sheet metal screws and seal. Where air devices are installed on exposed ductwork, provide 4" extension collar with dimensions equal to the outside dimensions of the air device and mounting flange turned inward.

G. Diffusers shall be connected to flexible ductwork as follows:
   1. Fasten frames and borders to drywall ceilings where required.
   2. Slide flexible duct over collar of diffuser. Secure flexible duct to duct collar with flame retardant nylon cable tie(s) or stainless steel drawbands. Secure with an installation tool approved by the cable tie manufacturer. Nylon cable ties shall be 0.19 inch width minimum, with standard cross-section and shall comply with UL-181 or UL-2043.
   3. Clean construction dirt from diffusers.
   4. Remove damper operator knob and turn over to Owner's Representative.

H. Diffusers connected to rigid duct shall be installed as follows:
   1. Fasten frames and borders to drywall ceilings where required.
   2. Fasten extension duct collar to ductwork with sheet metal screws (and seal with approved duct sealer).
   3. Fasten duct ring to extension duct collar with sheet metal screws.
   4. Clean construction dirt from diffuser.

I. Grilles and Registers shall be connected to the ductwork as follows:
   1. Cut hole in return or exhaust duct.
   2. Fasten extension duct collar to ductwork.
   3. After ceiling or wall is installed, install register with sheet metal screws.
   4. Check to see if sponge rubber gasket is drawn up against wall or ceiling, forming an air tight seal. If not, reassemble and check.
   5. Clean construction dirt from register.
6. Remove damper operator key from register and turn over to Owner's Representative.

J. All grilles, registers and diffusers shall be left in a wide open position.

K. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, regardless of whether dampers are specified as part of the diffuser, or grille and register assembly.

L. Paint ductwork visible behind air outlets and inlets matte black.

M. Provide supplemental “tees” for the ceiling grid where diffusers are a different size than the ceiling tiles.

3.21 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a primer that is compatible with the duct material.

3.22 SHOP APPLICATION OF LINER IN RECTANGULAR DUCTS

A. The duct liner shall be cut to assure snug corner joints and installed so the black surface of the liner faces the air stream. Fold and compress liner in corners to assure butted edge overlapping.

B. Adhere a single layer of indicated thickness of duct liner with 100 percent coverage of adhesive at liner contact surface area. Multiple layers of insulation to achieve indicated thickness is prohibited.

C. On horizontal runs, tops of ducts over 12" wide and/or sides over 16" high shall be additionally secured with Gripnail or welded pins and speed clips on a maximum of 15" centers.

D. On vertical runs, Gripnail or welded pins and speed clips shall be spaced on a maximum of 15" centers on all duct dimensions over 12".

E. Mechanical fasteners shall start within 2" of leading edge of each section, and within 3" of the leading edge of all cross joints within the duct sections. Mechanical fasteners shall be flush with the liner surface. Clips shall be drawn down flush only and not so as to compress the liner and cause the leading edge to raise up.

F. All exposed edges and the leading edge of all cross joints of the liner shall be sealed with edge sealer.

G. Butt transverse joints without gaps and coat joint with adhesive.

H. Longitudinal joints in rectangular ducts shall not occur except at corners of ducts, unless the size of the duct and standard liner product dimensions make longitudinal joints necessary.

I. Secure transversely oriented liner edges facing the airstream with metal nosings that are either channel or "Z" profile or are integrally formed from the duct wall at the following locations:
1. Fan discharge and upstream edges of transverse joints within 40 feet of the fan discharge.
2. Where lined ducts are preceded by unlined ductwork.

J. Terminate liner with duct build outs (metal hat sections) installed in ducts to attach dampers, turning vane assemblies, and other devices. Secure build outs to the duct wall with bolts, screws, rivets, or welds. Terminate liner at fire dampers at connection to fire damper sleeve through fire separation.

K. Duct liners having a rough surface that produces an Air Friction Correction Factor greater than specified shall have the duct oversized by the sheet metal contractor to achieve the Air Friction Correction Factor indicated.

L. Do not use multiple layers of duct liner unless approved by the Engineer in writing. If multiple layers are used, the following additional steps shall be taken:
   1. Adhere bottom layer of duct liner in normal manner.
   2. Adhere top layer of duct liner to bottom layer using a minimum of 90% adhesive coverage.
   3. Treat the leading edges of the duct liner with metal nosing to prevent separation of the two layers.
   4. Use mechanical fasteners of the proper length for the double layer.

M. The following ducts require internal lining with a 1.5 pdf density and liner thickness indicated:
   1. All new rectangular supply and return ductwork - 1” thick.
   2. All rectangular supply ductwork for the heat recovery system - 1” thick.
   3. All rectangular exhaust ductwork for the heat recovery system - 1” thick.
   4. Other ducts where indicated on the drawings - 1” thick.

N. External Duct Insulation: See Section 230200 - Mechanical Insulation for application requirements.

END OF SECTION 230900
SECTION 23 09 10 – START-UP, CLEANING AND TESTING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish all labor, services, materials and related items necessary to complete the start-up, cleaning and testing work indicated on the drawings and/or specified herein. Work to be performed shall include, but not be limited to, the following items:

1. All Air Systems
2. Natural Gas Piping
3. Refrigerant Relief Piping
4. Condensate Drains

1.2 RELATED DOCUMENTS

A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.

B. Section 230000 - General Mechanical Conditions.

PART 2 - PRODUCTS

2.1 PIPE CLEANING CHEMICALS

A. Vulcan Precleaner or approved equal by Nalco or Calgon.

PART 3 - EXECUTION

3.1 START-UP OF SYSTEMS AND EQUIPMENT

A. Before any systems, or parts of systems are placed into unattended operation, they shall be completely installed, pressure tested, cleaned, flushed and balanced with all operating and safety controllers installed, calibrated and operational.

B. When started, all motors shall be checked for proper rotation, speed, and amperage. If overloading is indicated, immediate corrective measures shall be taken to prevent damage to the motor.

C. Before systems are operated, all bearings shall be lubricated and all other liquid levels and pressures checked and if necessary corrected.

D. Contractor shall start-up all systems and equipment and place all systems into operation. Any equipment, pieces of equipment, controls, etc., damaged or not operating properly shall be replaced at this contractor's expense.

E. Contractor shall verify proper and safe operation of all equipment, components, controls and control circuits before any system is left unattended.

F. Whenever air systems are operated, air filters shall be in place. Air systems shall not be operated at any time without filters.
3.2 PIPE SYSTEMS TESTING

A. Perform the following tests on refrigerant piping:
   1. See test requirements in Section 230150 “Refrigerant Piping.”

B. The following pipes do not require a pressure test:
   1. Air Handling Unit and DX coil condensate drains.

C. Any item which might be damaged by the pressure test shall be removed from the system during the test, or isolated from the test.

D. Gauges used for testing shall be tested for accuracy, and then installed as close as possible to the low point of the system to be checked.

E. No leakage is permitted. Leaks shall be repaired and the lines retested.

F. Any lines changed after testing shall be retested.

G. Test data shall be recorded on a standard form.

H. While piping is under test, care shall be taken that excessive pressure does not occur due to increase of ambient temperature.

I. Test Pressure and Medium:

<table>
<thead>
<tr>
<th>LINE SERVICE</th>
<th>MEDIUM</th>
<th>TEST PRESSURE PSIG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas</td>
<td>Air</td>
<td>100</td>
</tr>
<tr>
<td>Refrigerant Relief Piping</td>
<td>Dry Nitrogen</td>
<td>200</td>
</tr>
</tbody>
</table>

3.3 CLEANING

A. Adequate precautions shall be taken during storage and installation to keep the inside of all pipes, valves and fittings free from foreign materials.

B. The inside of all pipes, valves, and fittings shall be smooth, clean, free from blister, loose mill scale, sand, dirt and other foreign material.

C. This Contractor shall clean all piping installed by him.

D. Natural gas piping shall be cleaned with compressed air. Piping shall be thoroughly blown clean. When complete, all dirt legs, strainers, etc., shall be cleaned. Any items in the piping system, such as gas trains or equipment, which could be affected by either the pressure or dirt shall be disconnected during the cleaning operation.

3.4 TURN OVER TO OWNER

A. Perform the following before operating the system:
   1. Open manual valves fully.
   2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.

B. When the system is turned over to the Owner, all systems shall have been started, tested, balanced and checked and proven to be fully operational in every respect.

C. When the system is turned over to the Owner, all bearings shall have been recently lubricated, oil levels checked and oil added if necessary, liquid levels and pressures checked and corrected, flow rates checked and corrected, R.P.M.'s verified, belts tightened and aligned, and all controls and control sequences checked, verified operational and if necessary, corrected.

D. When the system is turned over to the Owner, all air filters shall be replaced with clean filters.

END OF SECTION 230910
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SECTION 23 09 30 – TESTING AND BALANCING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK
   A. Furnish all labor, services, materials and related items necessary to complete the testing and balancing (TAB) work indicated on the drawings and/or specified herein. The scope of work shall include:
   1. Balancing of all air movement systems.
   2. Adjusting all air devices to prevent drafts on occupants or as otherwise indicated.

1.2 RELATED DOCUMENTS
   A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.
   B. Section 230000 - Mechanical General Conditions.
   C. Section 230010 - Mechanical Basic Materials and Methods.
   D. Section 230020 - Vibration Isolation and Seismic Restraints.

1.3 All instruments used by this agency shall be accurately calibrated and maintained in good working order.

1.4 The balance work shall be performed by an AABC (Associated Air Balance Council) or a NEBB (National Environmental Balance Bureau) certified firm. All work shall be done in compliance with the standards of the certification. All balance work shall be done under direct supervision of a qualified heating and ventilating engineer employed by them. All work shall also comply with the ASHRAE Standard 111 recommendations pertaining to measurements, instruments, testing, adjusting and balancing.

1.5 The balance firm shall have a minimum of 5 year’s experience balancing similar systems.

1.6 If requested, the tests shall be conducted in the presence of the Engineer or their representative.

1.7 REFERENCES
   A. AABC - National Standards for Field Measurement and Instrumentation, Total System Balance.

1.8 SUBMITTAL
   A. Provide submittals under provisions of Section 230000.
   B. Within 30 days of award of the contract, submit:
      1. Name and qualifications of testing, adjusting and balancing agency for approval by the Engineer.
      2. Submit sample balance report forms and detailed procedures for approval by the Engineer.
3. Forms shall be representative for all the tests. Formulas and data to be used for determining heat exchange capacities, where required, shall be included.

C. Submit 3 bound copies of draft report for review prior to final acceptance of Project.

D. Submit 5 bound copies of final reports to the Engineer for inclusion in operating and maintenance manuals.

E. Provide reports in soft cover, letter size, multi-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

F. Reports shall include the following information:
   1. TAB Company name, address, and telephone number.
   2. Project name, location, Project Architect, Project Engineer, and Project Contractor.
   3. Project altitude.
   4. Instrument List:
      b. Manufacturer.
      c. Model.
      d. Serial number.
      e. Range.
      f. Calibration date.

1.9 QUALITY ASSURANCE

A. Agency shall be company specializing in the adjusting and balancing of systems specified in this Section with minimum three years documented experience. Perform work under supervision of AABC Certified Test and Balance Engineer.

B. Total system balance shall be performed in accordance with AABC National Standards for Field Measurement and Instrumentation, Total System Balance.

1.10 SCHEDULE

A. Sequence work to commence after completion of systems. Schedule completion of TAB work before Substantial Completion of Project.

1.11 PREPARATION FOR TESTING AND BALANCING

A. The Mechanical Contractor shall bring the work to a state of readiness for testing and balancing all equipment and systems by doing the following:
   1. Install air terminal devices.
   2. Install all balancing devices. Leave them accessible, readily adjustable, and in the open position.
   3. Verify lubrication of all equipment.
   4. Permanent instrumentation to be operational.
   5. Check rotation and alignment of rotating equipment and tension of belt drives.
6. “Start-up” HVAC equipment and continue operating the equipment during the testing and balancing.
8. Set control points of automatic controls and check calibrations and adjustments.
9. Repair or replace at this contractor’s expense components of system which do not function properly.

B. Mechanical Contractor shall assist the balance firm as follows:

1. Provide TAB firm with copy of the HVAC plans, specifications and approved equipment submittals.
2. Change, at the Mechanical Contractor’s expense, pulleys, belts, drive, etc., required to obtain correct air balance.
3. Add, at the Mechanical Contractor's expense, dampers and/or valves as required by the TAB firm to correctly balance the HVAC systems.
4. Repair duct leaks identified by the TAB firm.
5. Put all HVAC equipment and systems into operation and continue the operation during each working day of TAB, as required.
6. Providing test holes in ducts and plenums where directed by TAB to allow air measurements and air balancing. Providing an approved plug.
7. Provide temperature and pressure taps according to the Construction Documents for TAB testing.

1.12 DEMONSTRATION

A. Demonstrate as follows:

1. The TAB Firm shall be prepared to demonstrate to the Engineer and the Owner that actual conditions match the balancing report. At the Engineer’s discretion:
   a. Retest no more than 30% of the supply, return and exhaust outlets to demonstrate that they are reading what the balance report indicates.
   b. Retest no more than 30% fan/pump, etc., systems to demonstrate that they are operating at conditions indicated in the balancing report.
   c. Retest no more than 30% of controls relative to the mechanical equipment to demonstrate that they are operating properly.
   d. Retesting shall be done in cooperation with the Engineer and the Owner’s personnel and in their presence if requested.

PART 2 - PRODUCTS

2.1 MEASUREMENTS AND INSTRUMENTATION

A. Provide all required instrumentation to obtain proper measurements, calibrated to the tolerances specified in the referenced standards. Instruments shall be properly maintained and protected against damage.

B. Provide instruments meeting the specifications of the referenced standards.
C. Use only those instruments which have the maximum field measuring accuracy and are best suited to the function being measured.

D. Apply instrument as recommended by the manufacturer.

E. Use instruments with minimum scale and maximum subdivisions and with scale ranges proper for the value being measured.

F. When averaging values, take a sufficient quantity of readings which will result in a repeatability error of less than 5 percent. When measuring a single point, repeat readings until 2 consecutive identical values are obtained.

G. Take all reading with the eye at the level of the indicated value to prevent parallax.

H. Use pulsation dampeners where necessary to eliminate error involved in estimating average of rapidly fluctuation readings.

I. Take measurements in the system where best suited to the task.

J. Prepare and submit a profile of the air flow across all coils in all air handling units.

PART 3 - EXECUTION

3.1 The TAB firm shall provide the following services:

A. Test and balance the air distribution and exhaust system to within 10% of design conditions in accordance with the following:

1. Measure and record the following initial and final fan data for each rooftop unit and exhaust fan: fan total static pressure, fan RPM, fan motor current and total CFM.
2. Make adjustments in fan RPM as required to obtain the required total CFM, outside air CFM and return air CFM.
3. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
4. Adjust balance dampers as necessary for design air flow from each diffuser and to each exhaust and return grille. Use volume control devices on air devices to regulate air quantities only to extent that adjustments do not create objectionable sound levels. Effect volume control by duct mounted dampers. Report required CFM and resultant CFM after final adjustments. Report percent of design air flow.
5. Adjust balance dampers as necessary for design air flow from each diffuser and to each exhaust and return grille. Use volume control devices on air devices to regulate air quantities only to extent that adjustments do not create objectionable sound levels. Effect volume control by duct mounted dampers. Report required CFM and resultant CFM after final adjustments. Report percent of design air flow.
6. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts and install test ports.
7. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

8. Adjust deflection vanes on all air devices as indicated on plans and schedules and to minimize drafts in all areas. Adjust return air devices to block line of sight into return air duct or plenums.

9. Examine HVAC equipment with functioning controls is ready for operation and terminal units, such as variable-air-volume boxes, are accessible and their controls are connected and functioning.

B. Test and balance the control system and make temperature tests in accordance with the following:

1. In cooperation with the control contractor, check all devices in the control system for function and calibration.
2. Measure temperatures (EAT and LAT as applicable) at all rooftop units, coils, etc. when this equipment is operating under maximum load or conditions similar to maximum load for both heating and cooling.

C. Motor rotation and speed shall be checked and recorded for all motors.

D. Proper air flows shall be demonstrated in minimum outside air, full outside air (economizer), and intermediate positions. Intermediate positions shall be carefully observed to insure that no overloading or other objectionable conditions occur. Should any objectionable conditions occur, the Engineer shall be notified of the conditions and their causes.

E. Submit reports of discrepancies, deficient or uncompleted work by others to the GC and Owners Rep at least once a week prior to submitting a draft test and balance report.

F. Submit draft test and balance reports. Coordinate with Engineer and MC to resolve deficiencies.

G. Submit final test and balance reports when deficiencies have been resolved.

3.2 The TAB firm shall perform the following tests and balance the system in accordance with the following requirements. All equipment except air handler and RTU supply fans (see below for AHUs and RTUs) shall be balanced to within 10% of design flow.

A. Air Handling Equipment (AHUs, RTUs, FURNACES, MUAs, etc.):

1. Air flow, specified and actual.
2. Return air flow, specified and actual.
3. Outside air flow, specified and actual.
4. Total static pressure (total external), specified and actual.
5. Inlet pressure.
6. Discharge pressure.
7. Fan RPM.

B. Exhaust /Supply Fan Data:

1. Air flow, specified and actual.
2. Total static pressure (total external), specified and actual.
3. Inlet pressure.
4. Discharge pressure.
5. Fan RPM.

C. Return Air/Outside Air Data:
   1. Design air flow.
   2. Actual air flow.
   3. Design return air flow.
   4. Actual return air flow.
   5. Design outside air flow.
   6. Actual outside air flow.
   7. Return air temperature.
   8. Outside air temperature.
   9. Required mixed air temperature.
   10. Actual mixed air temperature.
   11. Design outside/return air ratio.
   12. Actual outside/return air ratio.

D. Electric Motors:
   1. HP/BHP.
   2. Phase, voltage, amperage; nameplate, actual, no load.
   3. RPM.
   4. Service factor.
   5. Starter size, rating, heater elements.

E. Air Distribution Test Sheet:
   1. Identify and locate each air device. Use manufacturer's ratings on all equipment to make required calculations. Report required CFM and resultant CFM after final adjustments. Report percent of design air flow.
   2. Balance all supply, return, and exhaust air devices to within 10% of design flow. Use volume control devices on air devices to regulate air quantities only to extent that adjustments do not create objectionable sound levels. Effect volume control by duct mounted dampers.
   3. Adjust deflection vanes on all air devices as indicated on plans and schedules and to minimize drafts in all areas. Adjust return air devices to block line of sight into return air duct or plenums.

END OF SECTION 230930
SECTION 23 09 61 – TEMPERATURE CONTROL WIRING

PART 1 - GENERAL

1.1 The Plans, the general provisions of the Contract including the General, Supplementary and/or Special Conditions and specification sections of Division 1 shall apply to Work of Division 23 of the Specifications.

1.2 Provisions and conditions cited in this Section shall apply to Work for other sections of Division 23 of these Specifications.

1.3 REFERENCES, REGULATORY REQUIREMENTS

A. Work for this Section of the Specifications shall be performed in accordance with the Codes, Standards, etc. as identified in Section 230000 in addition to the following:

1. N.E.C., NFPA 70 – 1999
2. FCC rules, Part 15, Subpart J, regarding Class A radiation for computing devices and low power communication equipment operating in commercial environments.

1.4 RELATED DOCUMENTS

A. Section 230000 - Basic Mechanical Conditions.
B. Section 230010 - Basic Mechanical Materials and Methods.

1.5 DEFINITIONS

A. The term “Control Wiring” where used in this Section of the Specifications shall be defined as all wiring, 120 VAC line voltage or lower, other than power wiring, required for the proper operation of the mechanical system and the BAS. This includes applications where line voltage serves as the control circuit such as a line voltage thermostat or involves interlocking with a damper.

B. The term “Power Wiring” where used in this Section of the Specifications shall be defined as all line voltage wiring to the mechanical and BAS equipment that is required for proper operation of the equipment. Typically, this wiring will support voltage at or above 120 VAC and is connected to the equipment for the purpose of providing motive power.

1.6 WORK INCLUDED

A. Furnish material, labor and services necessary for and reasonably incidental to the installation of the following work where shown on the Plans and as hereinafter specified. Include all necessary work in the related sections of the Specifications to perform the Work completely.

B. All engineering, labor, material, components, tubing, wiring, etc., as required for a complete operational control system as described on the drawings, in the specification, and as required by good practice.

1.7 SUBMITTALS
A. The Contractor shall submit the following for approval in accordance with other specification sections.

1. Conductors
2. Hangers
3. Attachment devices
4. Raceways
5. Boxes

1.8 COORDINATION WITH EXISTING SYSTEMS

A. The control contractor shall provide coordination as required for a properly functioning and installed system.

1.9 ACCEPTANCE TESTING AND WARRANTY

A. The building control system, including all hardware and software components installed by this Controls Contractor shall be warranted for a period as identified in Division 1 specifications and front end documents. Any manufacturing or installation defects arising during this period shall be corrected without cost to the Owner.

B. The existing building control system, including all hardware and software components may be reused as part of the system to meet the requirements of the sequence of operation or input list, provided that they are serviced and placed in first class operating condition.

PART 2 - PRODUCTS

2.1 GENERAL

A. The Bidders are responsible for confirming that the equipment they are supplying will conform to the specifications presented. Deviations from the specifications should be brought to the attention of the Engineer.

B. All materials and equipment used shall be standard components, regularly manufactured for this system and shall not be custom designed especially for this project. All components shall have been thoroughly tested and proven in actual use.

2.2 POWER FOR CONTROL PANELS, EQUIPMENT AND SYSTEMS

A. The Controls Contractor shall be responsible for bringing all power required by the control systems from the source (lighting panel, distribution panel, etc.) to the point of use.

B. This section shall be responsible for bringing all power required by, but not limited to, actuators, transmitters, etc. from the source (lighting panel, distribution panel, etc.) to the point of use. This includes furnishing and installing any branch circuit protection equipment and disconnecting equipment required to comply with code requirements.

C. The Contractor shall extend existing equipment grounding system. The Contractor shall use only approved grounding clamps and connectors as manufactured by Penn-Union, Burndy, or O-Z Manufacturing Company.
1. Install a green equipment grounding conductor inside all conduits. Bond all junction boxes, conduit, and equipment. Terminate equipment grounding conductor at electrical panel grounding bus.

2.3 WIRING

A. All wiring required for work under Section 230960 of the specification shall be provided under this section of the specification.

2.4 CONDUIT AND WIRE

A. All wiring shall comply with applicable codes and regulations and shall be as specified in the applicable portions of this section of the specification, the electrical section of the specification, and as indicated on the drawings.

1. Conduit shall be required for: all power wiring, input/output wiring exposed to view in finished spaces, all thermostat rough-ins, wiring below 8’ AFF exposed to view in unfinished spaces.
2. Open wiring will be permitted: above lay-in ceilings, and unfinished spaces above 8’ AFF.
3. Plenum rated wire shall be used in spaces used for the return air system.
4. Cable tray may be substituted for conduit at the Contractor’s option for input/output wiring in mechanical equipment rooms.
5. Wire mold shall be required for all low voltage wiring for thermostats installed on concrete columns. Wire mold shall be similar to Wire mold Series “2700”.

B. Conduit Material:

1. Electrometalic tubing shall be installed for all exposed work and for all concealed work in applications where conduit is required.
2. Provide conduit as specified in Specification Section 260130.

C. Provisions for Wiring: Wire and cable shall be furnished and installed by the Contractor. All wire and cable shall be new soft drawn copper and shall conform to all the latest requirements of the National Electrical Code, IPCEA, and shall meet the specifications of the ASTM.

D. Power Conductors: Provide conductors for all feeders and branch circuits as specified in Specification Section 260120.

E. Motor Interlock Wiring: Interlock circuit wiring shall be No. 14 solid or stranded wire. Stranded wire only shall be used where wiring is used for flexible wiring harnesses. Stranded control wire shall be provided with crimp type spade terminators. Interlock circuit wiring shall be color-coded or numbered using an identical number on both ends of the conductor. Wire numbers shall be installed before conductors are pulled. Where motor interlock conductors are run in cable tray, furnish and install conductors or multi-conductor cable rated for use in cable trays per NEC articles 340 and/or 725.

F. Automation Input/Output Wiring: Wiring serving inputs and outputs from the automation system shall be cables consisting of single or multiple twisted individually shielded pairs. Each pair shall have an independent shield with drain wire. Cables installed without conduit shall be
plenum rated and comply with NEC article 725. Multi-conductor cable shall only be used where all the points are at a single location and for the same device (i.e., variable frequency drives, each individual motor starter). Single conductor cables shall be used for all temperature transmitters, pressure transmitters, flow meters, differential pressure switches, control valves and any other locations where the points are not grouped together at the same device. Where automation input/output wiring is run in cable tray furnish and install conductors or multi-conductor cable rated for use in cable trays per NEC articles 340 and/or 725. Conductors shall be minimum #18 wire gauge. All wires shall be continuous from outlet to outlet and there shall be no unnecessary slack in the conductors.

G. Floor level network (FLN): Wiring serving communication trunks from the automation system shall be cables consisting of single twisted individually shielded pairs. Each pair shall have an independent shield with drain wire. Cables installed without conduit shall be plenum rated and comply with NEC article 725. Where automation input/output wiring is run in cable tray furnish and install conductors or multi-conductor cable rated for use in cable trays per NEC articles 340 and/or 725. Conductors shall be minimum #18 wire gauge.

H. Splices: All splices, taps, and terminations shall be made at outlet, junction, or pull boxes. Wire to No.6 gauge shall be spliced using Scotchlok wire nuts. No Bakelite wire nuts shall be used. Wire No. 6 and larger shall be spliced using solderless connectors as manufactured by Penn Union Company. Splices No. 6 and larger shall be insulated by taping with plastic vinyl tape as manufactured by Minnesota Mining and Manufacturing Company. Splices shall not be permitted in automation input and output wiring without specific written authorization from the Engineer. If such a splice is approved, the location of the splice shall be clearly documented on the “As Built” drawings. Splices in automation wiring, if necessary, shall be made using Thomas & Betts STA-KON connectors installed per the manufacturer’s directions to maintain NEMA specified voltage drops and wire retention forces.

I. Pilot lights where shown or required will be the push-to-test type and will be provided with two spare bulbs per lamp.

2.5 JUNCTION BOXES, FITTINGS AND WIREWAYS

A. Quality: All switch, pull, junction boxes, etc., shall be hot dipped galvanized or sherardized, concrete tight, with interlocking ring or multiple point locking devices. Connectors shall be three piece. Indentation fittings are not acceptable.

B. Attaching: Boxes shall be attached by fasteners designed for the purpose and shall provide adequate mechanical strength for future maintenance.

C. Size: Junction and pull boxes shall be minimum 4 inch square, or larger as required by NEC.

D. Furnish and install at all control panel locations a NEMA 1 wire way system to bring cable into and out of the panel. Furnish 3 wire-ways at each panel location; one for tubing, one for Class 1 wiring, and 1 for Class 2 and Class 3 wiring.

E. All wiring leaving the panel shall be separated by classification; i.e., Class 1 circuits shall not be run with Class 2 circuits, etc. Segregation shall be maintained inside the panel to the fullest extent possible. Where low voltage wires carrying low level AC and DC signals cross wires containing power and high level AC signals, the wires shall cross at a 90 degree angle.
F. Wireway systems at locations where cables are to be run without conduit or in a cable tray shall consist of a connection to the control panel with a vertical extension to 8’0” or the pipe rack or cable tray level, whichever is higher. The vertical section shall terminate in a 90° fitting with a closure plate. The closure plate shall be provided with a conduit nipple with locknuts and bushings as a wire entry point into the square duct. The conduit nipple shall be 1 size smaller than the wireway it is associated with.

G. Wireway systems at locations where cables are to be run in conduit shall consist of a horizontal section of wire way with a length equal to the control panel width and located above the control panel and connected to the control panel with 3 conduit nipples, locknuts, and bushings; one for tubing, one for Class 1 wiring and one for Class 2 and 3 wiring. Conduits for cable runs shall terminate on the wireway.

H. The intent of the wireway configurations outlined above is to provide a method for adding input and output wiring to the control panel without having to drill directly into the electronics enclosure after the system is on line and running. The installation of the wireway shall be made with this consideration in mind.

2.6 SAFETY CIRCUITS

A. All safety circuits shall be hard-wired circuits using standard snap acting electric or pneumatic switches as required by the function, and shall be totally independent of the DDC system controllers. Operation of safeties shall be independent of the position of any Hand-Off-Auto selector switches. This includes interlocks that return dampers and valves to some normal, fail-safe position when the system they are associated with shuts down. It is the intent of this paragraph that the systems have the capability to be operated manually complete with safeties and fail safe interlocks even if the DDC system is off line. Software safeties will not be accepted.

2.7 HANGERS AND ANCHORS

A. Where control system tubing is run on trapezes and/or hangers used by and or installed by other trades, supports for the trapezes shall be coordinated by all trades using the trapeze to assure that the anchor system is not overloaded and is sufficient for the load imposed including a margin of safety and seismic considerations. Under no circumstances shall a trapeze or hanger system installed by the electrical trades be used to support work by any other trade, nor shall the electrical trades use the trapezes installed by any of the other trades for the support of electrical equipment, all as required by the National Electric Code. Similarly, under no circumstances shall a trapeze or hanger system installed by the sprinkler trades be used to support work by any other trade, nor shall the sprinkler trades use the trapezes installed by any of the other trades for the support of sprinkler systems or equipment, all as required by NFPA 13, Standard for the Installation of Sprinkler Systems.

B. Anchors to be loaded in tension for use in existing concrete structure and anchors loaded in tension and not cast in place shall be epoxy resin set anchors installed per the manufacturer’s recommendations for technique, size, loading, embedment, etc. Where anchors are loaded in shear at these locations, suitably sized and installed wedge type anchors may be used.
C. In all cases, anchor loading shall be based on hanger spacing, weight of the pipe to be supported when full and insulated, weight of any additional loads imposed upon the anchor, wind loading, seismic loading, quality of the material that the anchor is being installed in, etc. The contractor shall verify in the field that the anchors used and the materials that they are being installed in are suitable for the load imposed and shall bring any problems to the attention of the Owner's Representative in writing immediately and not proceed without direction from the Owner's representative.

D. Wedge type anchors shall be Hilti Kwik Bolt II. Adhesive anchors shall be Hilti HVA.

PART 3 - EXECUTION

3.1 WIRING SYSTEM

A. Install complete wiring system for electric and electronic control systems. Provide multi-conductor instrument harness (bundle) in place of single conductors where number of conductors can be run along common path. Fasten flexible conductors bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support conductors neatly.

B. Conceal wiring, except in mechanical rooms and areas where other conduit and piping are exposed.

1. Wiring in the ceiling, attic and within wall cavities may be cable.
2. Wiring to thermostats, temperature sensors, or other devices on walls without cavities shall be in wiremold (almond color). Other wiring shall be in conduit.
3. Exposed wiring to rooftop mounted units, condensing units, and other units that are outside the building shall be in conduit.

C. Low voltage control wiring and 24 VAC wiring can be run in the same conduit. Power wiring over 24 volts (i.e. 115 VAC or greater) must be in a separate conduit.

3.2 CONDUIT INSTALLATION

A. Conduit bends shall be made with standard hickeys of proper size; radius of bends to be at least 6 times the diameter of the conduit. Runs between outlets shall not contain more than the equivalent of three-quarter bends. Conduit runs shall be continuous from outlet to outlet, outlet to cabinet, etc.

B. Conduits shall be installed with pitch toward outlet box wherever possible. All heavy wall conduits shall have two locknuts and a bushing at each termination outlet box, junction box, etc., except where terminated in a threaded hub. Fittings on electro-metallic tubing shall be compression type.

C. A bushing shall be used where conduit enters a panel box. Bushing for No. 4 AWG or larger shall be insulated type with provisions for grounding as type “BL” made by O-Z Electric Company, or approved equal.

D. All conduits shall be installed parallel or at right angles to the building walls or floors.
E. Expansion fittings shall be provided at all conduits across the building expansion joints. Fittings shall be Type “AX” or “TX” as made by O-Z Electric Company, or approved equal. Provide copper bonding jumper at each expansion fitting.

F. Exposed conduit shall be securely fastened in place on maximum 5 ft. intervals for ¾” through 2-1/2 inch nominal sizes. Supports may be one hole malleable straps or other approved devices. No perforated metal straps will be permitted.

G. Pull boxes and junction boxes shall be installed where indicated on the drawings or where required to facilitate wire installation. Locate in conjunction with other trades so as to install without conflict with other materials or equipment.

H. Care shall be used to avoid proximity to heat ducts and/or steam lines. Where crossings are unavoidable, conduit shall clear covering of line by at least six inches.

I. All conduit for automation wiring shall be identified by painting junction box covers as follows: Voltages above 24 shall be blue and red, voltages at 24 or below shall be blue.

3.3 INSTALLATION OF CABLES

A. Support cables installed in ceiling spaces every 5’ from the building structure with J-hooks, bridal rings or other approved supports. Cabling shall not be attached to electrical conduits, suspended ceiling grid system including ceiling support wires, ducts, sprinkler systems, gas, water pipes, or other pipes, etc.

B. Organize and group cables. Run through ceiling spaces following column lines. Do not install cable group runs diagonally across building.

C. All wiring shall be installed in accordance with local code requirements.

3.4 LABELING AND IDENTIFICATION

A. Provide labeling and identification as specified in Specification Section 16075 and as described below.

B. All wiring, tubing and cabling both inside and outside of control panels shall be labeled at both ends using Thomas and Betts EDP printable wire and cable markers using style WSL self-laminating vinyl. Input and output cables and wiring shall be labeled with the point number and the point description such as:

CPDPS005
Primary Heating Water
Pump #1 Proof of Operation

C. Cable and wiring not specifically associated with an input or output shall be labeled with a number and a function description such as:

+120 VAC Power
Panel DP2 Ckt 1

END OF SECTION 230961
SECTION 26 00 00 – BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Applicable provisions of Bidding Requirements and Division 1 General Requirements apply to work of this Section.

B. Should a conflict arise between this section and other Sections, the General and Supplementary Conditions of Division 1 shall take precedence.

C. The word "Contractor" as used in these specifications shall be held to mean the person, firm or corporation contracting to do the herein described work.

D. The submittal of a proposal carries with it the agreement to all items and conditions referred to in the specifications and accompanying drawings.

1.2 RULES AND REGULATIONS

A. The rules, regulations, ordinances of all applicable governing bodies in force at the time of execution of the Contract shall become a part of these specifications. These shall include the requirements of state, county, city and also the requirements of local utility companies.

B. All material furnished and work performed in the City of Arnold (House #1) shall be in compliance with the latest applicable versions of the following codes, including local ordinances and amendments:
   - International Building Code - 2015
   - National Fire Protection Association NFPA
   - National Electrical Code - 2014
   - OSHA Requirements
   - Americans with Disabilities Act, Standards for Accessible Design - 2010

C. All material furnished and work performed in Jefferson County (House #2) shall be in compliance with the latest applicable versions of the following codes, including local ordinances and amendments:
   - International Building Code - 2015
   - National Fire Protection Association NFPA
   - National Electrical Code - 2008
   - OSHA Requirements
   - Americans with Disabilities Act, Standards for Accessible Design - 2010

D. All electrical material used on this project must be UL listed and labeled.
E. Where a conflict exists between the applicable codes, the plans and the specifications, the one shall be followed that results in the higher quality, most expensive and most complete installation.

F. Install electrical equipment, devices and appurtenances in accordance with applicable standards and NECA 1-2010, "Standard Practice of Good Workmanship in Electrical Contracting."

1.3 PERMITS, LICENSES AND INSPECTION FEES

A. This subcontractor shall obtain and pay the cost of all fees, permits or licenses that may be required for the performance of the work described herein.

1.4 PLANS AND SPECIFICATIONS

A. The specifications and the accompanying drawings plans (architectural, site, structural, mechanical, electrical, fire protection and plumbing) are mutually explanatory and anything described or shown on one, but not on the other, shall be considered as if shown or described on all. The intention of the drawings and specifications is to provide complete functioning systems in every respect. Furnish all material and equipment and perform all labor to achieve this intent, whether or not such material or equipment is indicated herein. Whenever the term "provide" is used, it shall mean "furnish and install."

B. Data given herein and on the drawings is as exact as could be secured. Their absolute accuracy is not guaranteed. Obtain and verify exact locations, measurements, levels, space requirements, etc., at the site, and adapt the work to actual conditions at the building as constructed.

C. The drawings shall be considered schematic and are not intended to indicate all required materials. Conduit, wiring, equipment, etc., shall be installed so all items clear the structure and other building elements and maintain appropriate clearances for access, service and maintenance.

D. Some of the details on the drawings are schematic or diagrammatic. These details are not intended to show all materials, etc., required to achieve the arrangement shown. Adapt these details to the actual conditions of the job.

E. Routing of conduit and location of equipment and other devices are shown on plans for general guidance. This Contractor shall coordinate his work with other Contractors and shall provide necessary deviations in routing as far as 10 feet from those shown to provide systems as specified or implied, without interference and pursuant to these requirements at no additional cost to the Owner, Architect or Engineer.

F. Contractor shall not scale the drawings. Refer to architectural and structural drawings for building construction and dimensions and to room finish schedule on architectural drawings for material, finish and construction method of walls, floors and ceilings in order to insure proper rough-in and installation of contractor's work.

G. Changes, modifications or variations to the plans and specifications will be issued by the Engineer in writing.
H. Coordinate arrangement, mounting and support of electrical equipment.

1. To allow maximum possible headroom, unless specific mounting heights are indicated.
2. To provide for ease of disconnecting equipment with minimum interference to other installations.
3. To allow right-of-way for piping and conduit installed at slopes.
4. So connecting raceway will be clear of obstructions and of the working and access space of other equipment.

I. All mechanical, electrical, plumbing, and HVAC work shall be coordinated by that contractor and any correction to any of the above work shall be at that contractor’s expense.

1.5 DISCREPANCIES OR OMISSIONS

A. During the bidding period, any discrepancies or omissions in any of the documents or any doubt as to their meaning, should be reported to the Engineer who will, time permitting, issue a written instruction in the form of an addendum to all bidders of record. The Engineer will not be responsible for any oral explanations or interpretations of the documents.

B. During construction, should a discrepancy or omission be found, it shall be brought to the attention of the Engineer at once for resolution.

C. No changes in contract price will be allowed for minor changes in layout or location required to avoid interferences, obstructions, etc. Contract price changes will be considered only for changes in the scope of the project requirements. All such scope changes and price revisions must be authorized in writing.

D. If discrepancies are found within the contract documents, the most demanding requirement shall take precedence unless otherwise agreed by the engineer in writing.

1.6 VISITING THE SITE

A. Before submitting a bid, visit the site and become acquainted with the conditions under which the work will be performed.

B. Failure to fully understand the existing site conditions under which the work is to be performed will not be justification for additional compensation after the award of the contract.

C. Work in electrical rooms imparts labs outside the work area and contractor shall understand all conditions.

1.7 SHOP DRAWINGS

A. Contractor shall submit shop drawings in compliance with the General and Special Conditions. Contractor shall field verify exact locations, measurements, and space availability at the site, etc. prior to fabricating materials and shall notify the Engineer of discrepancies in writing.

B. The Contractor shall submit copies of all required Shop Drawings and material and equipment lists.
C. Submittals shall be transmitted to SSC Engineering as paper documents, electronic documents via email attachments, or electronic documents via FTP file transfers.

1. All submittals shall include a transmittal form identifying the project name, date, contents of submittal package, and names of subcontractor, manufacturer, and supplier.
2. On an attached separate sheet clearly identify deviations from requirements in the Contract Documents, including minor variations and limitations.
3. Paper submittals shall be sent to
   
   SSC Engineering  
   Attention: Submittals  
   18207 Edison Ave.  
   Chesterfield, MO 63005.

4. Emails regarding submittals shall be sent to “submittals@sscengineering.com”.

D. Documents transmitted as email attachments shall be sent simultaneously to the Architect and SSC. SSC will return one (1) electronic copy of these documents to the Architect only.

E. Documents transmitted via FTP file transfers shall be retrieved from the FTP site after SSC has received an email notification that these documents have been posted to the site. SSC will return one (1) electronic copy of these documents to the Architect only unless another procedure is agreed to in writing by the Architect and the Engineer.

F. Contractor shall review and correct all shop drawings before they are submitted. Shop drawings shall bear the signed and dated approval stamp of this Contractor.

G. Shop drawings shall include the plan mark used on the plans.

H. Equipment shop drawings shall give capacities at conditions specified and shall include manufacturer’s catalog numbers and cuts. Shop drawings shall be clearly marked; shall indicate all accessories, items, conditions, etc., which are being furnished; and shall indicate that all conditions of the plans and specifications are being met. Wiring diagrams shall be submitted.

I. Submittals which do not provide the required information will be returned unchecked.

J. Contractor shall be responsible for deviations, errors and omissions, quantities, and coordination dimensions in submittals, and this responsibility shall not be relieved by Engineers' review of submittals.

K. This Contractor shall coordinate each submittal with the contract documents, work of other contractors, and job site conditions.

L. The Contractor shall not be relieved of responsibility for deviations from requirements of the Contract Documents by the Engineer’s approval of Shop Drawings, Product Data, Samples or similar submittals unless the Contractor has specifically informed the Engineer in writing of such deviation at the time of submittal and (1) the Engineer has given written approval to the specific deviation as a minor change in the Work, or (2) a Change Order or Construction Change Directive has been issued authorizing the deviation. The Contractor shall not be
relieved of responsibility for errors or omissions in Shop Drawings, Product Data, Samples or similar submittals by the Engineer’s approval thereof.

M. This Contractor shall coordinate each submittal with the contract documents, work of other contractors, and job site conditions.

N. Submit shop drawings on equipment as herein listed:

- Panelboards
- Load centers
- Primary load interrupters
- Motors and motor controls
- Fuses
- Conduit and boxes
- Conductors
- Wiring devices
- Grounding equipment
- Seismic restraints
- Interior lighting
- Exterior lighting
- Emergency generator
- Automatic transfer switch
- Fire alarm system
- HVAC smoke detection system
- Data equipment and wiring system
- Security system
- Lighting dimmer control system
- Surge protection devices
- Occupancy sensors

1.8 RELEASE OF CADD FILES

A. See “Release of Cadd Files Form” at the end of this section.

1.9 MAINTENANCE AND OPERATING INSTRUCTIONS AND MANUALS

A. Upon completion of the job, the installing contractors and major suppliers shall instruct the Owner’s representatives in the proper operation and maintenance of the systems installed. The installing Contractors shall submit documentation indicating the date of instruction; names and organization of persons providing and receiving the instructions; systems the instructions covered; and materials received.

B. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

1. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference
other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.

2. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.

C. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.

D. Contractor shall also submit four (4) complete hard copy sets and one (1) electronic copy of properly bound operating manuals to the Engineer for review. These manuals shall include the following:

1. Include a Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
2. Complete set of shop drawings.
3. Copies of all submittals.
4. Parts lists, wiring diagrams, piping diagrams, etc.
5. Manufacturers' operating and maintenance instructions.
6. Written operating and maintenance instructions for the system. This is a written version of Paragraph 1.9A above.
8. Parts lists for each piece of equipment and name of local supplier.

1.10 TEMPORARY POWER – NEW FACILITIES

A. The contractor’s temporary electric service facilities shall include all required panels, switches, protective devices, conduit, wiring, receptacles, etc., required to extend service and adequately distribute light and power in accordance with NEC Article 590. Coordinate details of service and metering for job site and construction offices with local utility company. Energy charges shall be paid by the General Contractor.

B. Temporary lighting shall consist of protected incandescent, LED, HID or fluorescent fixtures symmetrically spaced to produce a minimum of 5 footcandles throughout the work areas.

C. Temporary power panels shall be located on each floor of multi-story buildings. Panel area served shall not exceed 25,000 square feet. Each panel shall power 12-20A, 120V, quadraplex GFI receptacles. Locate quadraplex receptacles on each floor to permit work in all areas with extension cord not exceeding 100 feet in length.

D. Enclosed areas shall have adequate lighting.

E. The service shall be available during all working hours and scheduled overtime hours and otherwise as necessary for security and safety purposes, with security lighting to be provided during all hours of darkness. All such facilities shall conform to all requirements of the
National Electrical Code, the local utility, and all other governmental authorities having jurisdiction.

F. Temporary power shall be provided for all construction trailers.

G. Comply with NECA 200-2010, “Recommended Practice for Installing and Maintaining Temporary Electric Power at Construction Sites.”

1.11 AS-BUILT RECORD DRAWINGS

A. During construction, maintain a separate set of drawings at the jobsite to keep a record of all changes of locations. See additional requirements in General Conditions and Supplementary Conditions.

B. Locations of conduit and other concealed facilities shall be shown if and when they differ from the drawings. Underground conduit shall be dimensioned on those drawings.

C. "As built" drawings are to be submitted to Architect/Engineer for review prior to the time of request for final payment. Submit as-built record drawings in accordance with the General Conditions.

1.12 GUARANTEE AND WARRANTY

A. Guarantee and warrant equipment, materials, workmanship, installation, etc., for a period of one year in accordance with the General Conditions.

B. During the guarantee period, make all required repairs and replacements, and provide necessary service, labor, tools, materials, parts, etc., at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 MATERIAL SUBSTITUTION

A. Equipment selection has been based on one manufacturer to establish the desired type, style, quality, performance, etc. When other manufacturers are listed as equally acceptable, the product of those manufacturers will be accepted if their product complies with these specifications and drawings. The listing of a manufacturer does not relieve that manufacturer from complying with the specifications and drawings.

B. Equipment and materials are subject to the review and approval of the Engineer and Architect.

C. Differences in cost involved in using an equally acceptable manufacturer shall be included in the bid. Contractor shall be responsible for any and all engineering and installation variations due to the substituted equipment. These include structural, electrical, architectural, plumbing, mechanical, fire protection, etc. changes.

D. Deviations from these specifications are not solicited and are not encouraged. If a deviation between the specifications or drawings and items bid does exist, then that deviation must be clearly itemized and explained on the bid form.

PART 3 - EXECUTION
3.1 RESPONSIBILITY

A. Provide material, equipment, labor, services, supplies, etc., required to execute to completion work shown on the drawings, described in these specifications, or made necessary by the work shown on the drawings and/or described in these specifications.

B. Schedule work and furnish the required materials in such a manner that the work may progress from start to finish in an expeditious and efficient manner without undue interruption. Schedule the work to coordinate with the construction.

3.2 COORDINATION OF TRADES

A. Prior to the installation of any materials, review the drawings indicating work to be performed by each trade. If conflicts occur, they shall be brought to the attention of the Engineer for resolution.

B. Work installed without coordinating with the other trades, which causes interferences, shall be removed and reworked, at no cost to the Owner.

C. The Contractor supplying the equipment shall furnish all motors and components which are part of the equipment.

D. Control wiring is defined as that wiring which conducts electrical energy at a voltage of less than 100 volts. Interlock wiring is defined as that wiring which performs a control function, but at a voltage of 100 volts or greater. All other wiring shall be considered power wiring.

E. The Electrical Contractor shall furnish and install all power wiring to, and including connection to the equipment. Unless specifically noted otherwise, all interlock wiring shall be furnished and installed by the Electrical Contractor. Unless noted otherwise, the control wiring shall be furnished and installed by the Contractor furnishing the controlled equipment.

F. Unless noted otherwise, the Electrical Contractor shall furnish and install all starters, disconnects, switches, push-button stations, etc., except those which are furnished with the equipment as a part of a factory-assembled package. Heater elements for overload relays on magnetic motor starters (except the starters factory pre-wired with equipment) shall be sized, furnished and installed by the Electrical Contractor. Magnetic motor starters for mechanical equipment (except starters factory pre-wired with equipment such as chillers and packaged air conditioners) shall be furnished by the Electrical Contractor. Magnetic motor starters will be provided with:

1. Auxiliary contacts as required by the interlocks defined on the drawings or in the specifications.
2. Control Power Transformer - 120 volt secondary, minimum 40 Volt Amps.

G. Each Contractor furnishing motor-operated equipment shall furnish a list of motor characteristics to the Electrical Contractor so that properly sized heater elements may be provided. The list shall include equipment identification by name and by number, the full load current, locked rotor current, voltage rating, and suggested service factor to compensate for operating duty cycle and ambient temperatures.
H. Unless specifically noted otherwise, pilot controllers (aquastats, flow switches, pressure switches, etc.) shall be furnished and mounted by the Contractor furnishing the controlled equipment.

I. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls and other structural components as they are constructed.

J. Coordinate sleeve selection and application with firestopping specified in Division 7.

3.3 PROTECTION OF EQUIPMENT AND WORK

A. Protect and preserve materials, supplies, equipment, piping, etc., from damage due to weather, corrosion, dirt, vandalism, theft, etc. Provide enclosures or special protection as indicated by circumstances.

B. Should any of the materials, equipment, etc., be damaged as a result of their negligence, then this Contractor shall be held responsible for all such damage and costs incurred for repair or replacement.

3.4 CONSTRUCTION STAGING

A. Plan, coordinate and schedule the work to satisfy the project schedule.

B. Work shall be so arranged that electrical power and other services are available to the building at all times, except for short periods of interruption necessary for the performance of new work. Interruptions shall not be requested until the new services are complete and ready for final connection.

C. Interruptions shall be scheduled, and services shall not be interrupted without written approval of the Owner’s Representative. Notification to the Owner’s Representative shall include the exact time and estimated duration of any interruption.

3.5 EQUIPMENT FURNISHED BY OTHERS

A. Some pieces of equipment, as indicated on the drawings, will be furnished by the Owner’s vendor and/or under other Divisions of these specifications. Provide electrical work as shown for connections to this equipment.

B. Start-up of equipment furnished by the Owner’s vendor or under other Divisions of these specifications shall be the responsibility of this Contractor under the Section assigned the responsibility to receive and set in place or to move and set in place.

C. Warranties for equipment furnished shall be by the equipment manufacturer.

3.6 MAINTENANCE OF WORK AREAS

A. This Contractor shall maintain the work area in an organized manner, shall not allow debris to accumulate, and shall store equipment, tools and supplies in a manner which shall not cause interference with the activities of others engaged on the project.
B. Open ends of conduit, equipment and specialties shall be kept properly closed during construction and installation so as to avoid contamination.

3.7 CLEANING AND CLEANUP

A. Upon completion of this work, clean all panels, fixtures, and equipment. Leave all work in a finished, clean, and satisfactory working condition.

END OF SECTION 260000
RELEASE OF CADD FILES

The drawings prepared by SSC Engineering have been prepared using AUTOCAD 2018. Files for plan drawings prepared by SSC Engineering will be made available to the successful HVAC, plumbing, electrical and fire protection contractor by email; no other drawings will be released. The files will have background files bound in, borders and title blocks removed, and all notes, details, diagrams, and schedules removed. A release form must be signed. Utilization of these documents for the development of shop drawings and submittals does not relieve the contractor from any of his responsibilities herein.

Release form that must be signed:
As requested, SSC Engineering will provide ___________________________ (name of contractor) with electronic CADD files of the requested (M, E, P, FP) floor or ceiling plans on the terms set forth below. While SSC is not required under its contract to provide or update these electronic files for this purpose, they are being made available as a convenience to the contractor and as a substantial time saver in the preparation of submittals for this project.

The files contain information through the date when the drawings were issued for bidding and may or may not contain information from the addenda. The company using these files shall be responsible for the coordination of the information contained therein with the Plans, Specifications and other Contract Documents. In the event of any ambiguity, discrepancy or conflict between the information within the electronic files and the Contract Documents, the Contract Documents shall be used.

SSC will not be responsible for any error or malfunction in the translation, interpretation or use of this electronic information once it has been provided to the contractor. SSC does not assume any responsibility arising out of the use or adaptation of the information contained in these files or the sufficiency of any drawings prepared based upon the information included within. By accepting these drawing files, the contractor agrees to hold the Engineer harmless with regard to any errors or omissions in the drawing files. Nothing included in this release shall modify any requirements or responsibilities of either party under their respective contracts.

Signing below indicates understanding and acceptance of these terms. Upon receipt of a signed letter or fax, SSC will release the electronic CADD files.

Project Name and Number: ______________________________________________________

Specific Drawings Request: ______________________________________________________

Acknowledged and Agreed

_________________________ __________________________
Company Version of AutoCAD used

________________________________________________________
Name (Must be an officer of the Company) E-mail address

_________________________ __________________________
Title Maximum e-mail attachment size

_________________________
Date
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**SECTION 26 00 10 – BASIC ELECTRICAL MATERIALS AND METHODS**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.

B. Section 260000 - Basic Electrical Requirements.

**1.2 SCOPE OF WORK**

A. This section supplements all sections of this Division and shall apply to all phases of work hereinafter specified, shown on the drawings, or required to provide a complete installation of electrical systems.

**1.3 QUALITY ASSURANCE**

A. Electrical work including, but not limited to, installation, materials, equipment and wiring methods, shall comply with the applicable National Electrical Code, NFPA 70.

B. Equipment and materials shall comply with the applicable requirements of the following:

1. National Electrical Manufacturer Association (NEMA).
2. Institute of Electrical and Electronic Engineers (IEEE).
5. Underwriters Laboratories (UL).


**PART 2 - PRODUCTS**

**2.1** Provide products, components and materials which are listed and labeled by Underwriters Laboratories (UL). Test

**2.2 EQUIPMENT IDENTIFICATION LABELS**

A. 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. Overlay shall provide a weatherproof and UV-resistant seal for label.

B. 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.


**PART 3 - EXECUTION**

19-2726.01 & 19-2727.01
3.1 Install equipment and materials in a neat and workmanlike manner and align, level, and adjust for satisfactory operation. Install equipment so that all parts are easily accessible for inspection, operation, maintenance and repair.

3.2 SUPPORTS

A. Provide the design, fabrication, and erection of supplementary structural framing required for attachment of hangers or other devices supporting electrical equipment.

B. Provide members welded to structural members equal to the specification for the main structural member. Provide "simple beam" type framing with end connections welded or bolted for shear loads. Use cantilevers only when detailed or specifically approved by the Engineer. The Engineer's approval is required for location of supplementary framing.

C. Design framing members for their actual loads, with allowable stresses specified by AISC, without excessive deflection and with consideration for rigidity under vibration, in accordance with standard structural practices.

D. When supplementary framing is indicated, verify that dimensions are suitable for the equipment furnished. Provide additional strength when equipment furnished is heavier than that specified.

3.3 WIRING DEVICE LOCATION

A. Position of Outlets: Center all outlets with regard to paneling, furring and trim. Symmetrically arrange outlets in the room. Satisfactorily correct outlets improperly located or installed. Repair or replace damaged finishes. Set outlets plumb and extend to the finished surface of the wall, ceiling, or floor without projecting beyond same. Install symmetrically all receptacles, switches, and outlets shown on the trim or casework. Where necessary set the long dimension of the plate horizontal, or ganged in tandem.

B. Mounting heights, to center of box above finished floor, shall be as follows, unless otherwise indicated. Other mounting heights are indicated on the drawings by detail or by a plus dimension shown adjacent to the symbol:

- Switches: 46 inches
- Receptacles and similar devices: 18 inches
- Receptacles in mechanical rooms: 46 inches
- Motor controllers and disconnect switches: 60 inches to top
- Panelboards: 72 inches to top
- Exterior WP convenience outlets: 24 inches above grade
- Telephone: 18 inches
- Wall telephone outlets: 46 inches
- Television outlets: 18-90 inches
- Push buttons: 46 inches
- Fire alarm manual station: 46 inches
- Fire alarm, Audio/Visual alarm device: Lower of 80 inches above floor or 6 inches below ceiling.
C. Contractor shall review Architectural Elevations prior to rough-in to ensure coordinating heights and locations of devices with casework, equipment or shelving. Devices shall not be installed behind casework or within cabinets unless specifically noted.

3.4 IDENTIFICATION

A. General

1. All electrical equipment and devices shall be identified by nameplates or labels.

2. Nameplates - Shall be 4" x 1" x 1/8" thick white core, black face, plastic with engraved letters. Attachment to equipment shall be done by means of screws.

   a. Nameplates shall be used for all major equipment such as switchboards, motor panelboards, motor control centers, transformers, panelboards (lighting, power and auxiliary) on each switch and starter in each panelboard and motor control center, disconnect switches, relays/contactors, loose mounted motor starters, and on control panels serving fire alarm, security and public address system and motor circuits.

B. Equipment Identification

1. Panelboard - Nameplate shall designate panel number, upstream panel and voltage. Nameplate shall be mounted on the inside of panel door when the panel is located in finished areas and on the front of door when located in mechanical equipment rooms; typewritten branch circuit connection sheet shall be inserted within the panelboard manufacturer’s card holder.

2. Disconnect Switches and Motor Starters - Nameplates shall describe the equipment to be controlled and power circuit number.

3. Pushbutton Stations - Label shall identify the equipment controlled.

4. Transformers - Nameplate shall identify the equipment by plan designation, primary and secondary voltages, and KVA rating.

Labels (Stencils) - Shall be Brady or Westline and shall be color coded in accordance with ASA-Z34-1-53 "SAFETY COLOR CODE" to include system voltage, abbreviations of service, etc. For example: "480V", "Telephone", "Security", "Intercom", "Emergency", "120/208V", etc.

   a. In general, all exposed feeders, conduits, raceways, pull boxes, and junction boxes shall be identified.
   b. For conduit systems installed for future wiring installations, all conduits and pull boxes, both exposed and above ceiling, shall be identified.
   c. Labels shall be used on all bare or smooth painted surfaces. For rough textured surfaces, such as wrinkle painted surfaces or plastic materials where sticking labels would not be permanent, stencils or screwed on letters shall be used.

4. Label all low voltage wiring at both ends with Brady tags. Identify data and telephone cables by cable number and document on As-Built documents.
5. **Auxiliary System Equipment** - The control cabinets for auxiliary systems, such as fire alarm, P.A., intercom, program, etc., shall be identified with nameplate describing the system by designation, power circuit and voltage.

6. **Fusible Switches** - In addition to the nameplate, there shall be labeled on the inside of switch door, the fuse size required for equipment served.

7. **Junction and Pull Boxes** - Identify the function of the box such as "208 volt," "Telephone," "Fire Alarm," etc., with nameplates.

**C. Device Circuit Identification**

1. Receptacles connected to emergency power shall be identified by panel name and circuit number, with labels adhered to the device cover plate.

2. Receptacles connected to normal power shall be identified by panel name and circuit number, with labels adhered to the device cover plate.

**3.5 TEST**

**A.** Provide the tests as outlined hereinafter and other tests necessary to establish the adequacy, quality, safety, completed status and suitable operation of each system.

**B.** **Ground Rod Test:** Immediately after installation, test driven grounds and counterpoises with a Ground Resistance Direct-Reading Single-Test Megger, utilizing the AC Fall-of-Potential Method and two reference electrodes five (5) feet deep. Disconnect the ground rod to be tested from other ground systems at the time of testing. The ground resistance for the electrical service shall be 15 ohms or less. Submit the results, date of test, and soil conditions, to the Engineer in writing, immediately after testing.

**C.** [Emergency Responder Radio Coverage Test]

1. Contractor shall provide a radio signal strength and coverage test using spectrum analyzers to verify the building has adequate Emergency Responder Radio coverage in accordance with IFC 510. The Contractor shall coordinate timing of the test to occur near the end of the construction process after all steel, framing, concrete, windows, roof, etc are complete, but early enough to allow owner to address any potential deficiencies prior to final completion of the project. Any deficiencies in coverage shall be immediately reported to the owners, engineer and architect.

**D.** Balance phase currents of all distribution panels and branch circuit panels within plus or minus 10 percent variation between average phase current and measured individual phase currents.

**E.** Written test record shall be supplied to the Owner to show compliance with governing codes for grounding continuity.

**F.** Final Corrections: Correct promptly any failure or defects revealed by these tests as determined by the Engineer. Reconduct tests on these corrected items as directed by the Engineer.

**3.6 CONCRETE WORK**
A. Provide concrete work for electrical equipment as follows:

1. Nominal 4" concrete pads with chamfered edges and corners for switchboards, dry-type transformers, motor control centers, VFDs, ATSes and floor mounted panelboards. Concrete bases shall extend 1" beyond the equipment footprint unless specified otherwise.

2. Concrete base for free-standing exterior lighting equipment, including parking lot light poles, walk lighting, flood lights and other work as indicated on the drawings.

3. Provide concrete pad for utility transformer in accordance with utility requirements.

4. Provide concrete pad for exterior genset in accordance with plan details.

5. Concrete work shall comply with the requirements of Division 3. Minimum concrete strength at 28 days shall be 3000 psi. Provide reinforcing steel per ACI standards.

3.7 ROOF OPENINGS

A. Provide cutting, patching and flashing of roof for conduits through roof. Roof cutting and patching shall be coordinated with the roof installer. The original roof warranty shall be maintained.

3.8 PAINTING

A. Electrical equipment shall be factory finished standard color as furnished by the manufacturer. Scratches shall be touched up in the field after equipment is installed with paint which matches the original color.

3.9 EXCAVATION

A. Excavate, as necessary, for underground conduit, etc.

B. Material to be excavated shall be non-classified and shall include all earth or other materials encountered.

C. Unless otherwise shown, provide separate trenches for each utility. Install all conduit in open trench.

D. Excavation of trenches from surface to top of conduit shall be kept to a minimum but shall be of sufficient width for proper installation of the work. Provide ample excavation under and around all conduit joints to permit proper installation of connectors.

E. Excavations shall be properly protected by the necessary bracing and timbers to prevent any cave-ins or injury to adjacent improvements and workmen. The sides of all trenches shall be securely held by bracing or sheeting, which shall not be removed until the level of the backfill has reached the point where such removal can be safely carried out. The thickness of the sheeting and the dimensions of the cross-braces, shoes, etc., shall be satisfactory to protect properly the sides of the trench and to prevent injurious cave-ins or erosions.

F. Grading in the area of the excavation will be such that it shall prevent surface water from flowing into the excavated trench. Do not install conduit in water.
G. Where underground conduits cross, the trench of the lower conduit shall be backfilled with sharp sand, well tamped, to provide bed for higher conduit. Lines which run parallel and at different levels shall be adequately separated to provide firm bedding for the conduits.

3.10 BACKFILLING

A. Excavations shall be promptly backfilled.

B. Trenches for conduit, etc., shall be backfilled for a depth of at least one (1) foot over the top of conduit with minus. It shall be carefully deposited in uniform layers not exceeding six (6) inches in depth. Each layer shall be carefully and solidly tamped with appropriate tools in such a manner as to avoid injuring or disturbing the completed work. Backfill shall be placed thoroughly compacted to prevent lateral displacement.

C. Backfill from 1'-0" above the top of the conduit to 6" below grade shall be clean on-site materials. Rocks or other materials over 3/4" shall be removed. The last 6" of backfill shall be topsoil in planted areas, or earth in non-planted areas, or other materials as required by the architect, civil or site engineer when passing below asphalted or concrete areas. Place earth material in 6" to 8" maximum thickness layers and compact to dry density of at least 95% of maximum dry density as measured by Modified Proctor.

D. Backfill from 1'-0" above the top of the conduit to the bottom side of sidewalks, parking areas, streets, floor slabs or other paved areas shall be with crushed stone or gravel with maximum size of ½".

E. Do not place fill during rainy or freezing weather or on subgrade softened by rain or thawing action. When filling is interrupted by weather, top surface of fill shall be scarified, re-compacted, and tested before placing new fill. Each day's fill shall be constructed with a slope that will ensure free and rapid drainage.

F. If the soils are too wet during construction of the fill, air dry or scarify and re-compact.

G. The Owner shall have the option of requiring compaction tests. If the material tested does not meet these tests, this Contractor shall bear the cost of retesting and remedial work.

END OF SECTION 260010
SECTION 26 00 55 – SHORT-CIRCUIT / COORDINATION STUDY

PART 1 - GENERAL

1.1 WORK INCLUDED

A. The contractor shall furnish short-circuit and protective device coordination studies as prepared by a Licensed Professional Electrical Engineer as detailed in Qualifications paragraph below.

B. The Short Circuit study shall encompass the entirety of the electrical system; The Selective Coordination Study shall be limited to the Life Safety Branch of the electrical system.

C. The scope of the studies shall include new distribution equipment installed by Electrical Contractor under this contract.

1.2 RELATED SECTIONS

A. Drawings and general provisions of the Contract.

1.3 REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. IEEE 141 - Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
2. IEEE 242 - Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
3. IEEE 399 - Recommended Practice for Industrial and Commercial Power System Analysis
4. IEEE 241 - Recommended Practice for Electric Power Systems in Commercial Buildings

B. American National Standards Institute (ANSI):

1. ANSI C57.12.00 - Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
2. ANSI C37.13 - Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
3. ANSI C37.010 - Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis

C. The National Fire Protection Association (NFPA)

1. NFPA 70 - National Electrical Code, latest edition
2. NFPA 70E - Standard for Electrical Safety in the Workplace

1.4 SUBMITTALS FOR REVIEW / APPROVAL

A. The studies shall be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for 19-2726.01 & 19-2727.01
If formal completion of the study may cause delays in equipment shipments, approval from the Engineer may be obtained for a preliminary submittal of data to ensure that the selection of device ratings and characteristics will be satisfactory to properly select the distribution equipment. The formal study will be provided to verify preliminary findings.

1.5 SUBMITTALS FOR CONSTRUCTION

A. The results of the short-circuit; protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. A minimum of five (5) bound copies of the complete final report shall be submitted. For large system studies, submittals requiring more than five (5) copies of the report shall be provided without the section containing the computer printout of the short-circuit input and output data. Electronic PDF copies of the report shall be provided upon request.

B. The report shall include the following sections:

1. Executive Summary including Introduction, Scope of Work and Results/Recommendations.
2. Short-Circuit Methodology Analysis Results and Recommendations
3. Short-Circuit Device Evaluation Table
4. Protective Device Coordination Methodology Analysis Results and Recommendations
5. Protective Device Settings Table
6. Time-Current Coordination Graphs and Recommendations
7. One-line system diagram that shall be computer generated and will clearly identify individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location, device numbers used in the time-current coordination analysis, and other information pertinent to the computer analysis.

1.6 QUALIFICATIONS

A. The short-circuit and protective device coordination studies shall be conducted under the responsible charge and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.

B. The Registered Professional Electrical Engineer shall be an employee of the equipment manufacturer or an approved engineering firm.

C. The Registered Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies.

D. The calculations shall be signed and sealed by a registered professional engineer of the state in which the project occurs.

1.7 COMPUTER ANALYSIS SOFTWARE

A. The studies shall be performed using SKM Systems Analysis Power*Tools for Windows (PTW) software program or equivalent from ETAP.
2.1 STUDIES

A. The contractor shall furnish a study to include short-circuit and protective device coordination studies. All studies to be prepared by the Licensed Professional Electrical Engineer.

2.2 DATA

A. Contractor shall furnish all data as required for the power system studies. The Engineer performing the short-circuit; protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

B. Source combination may include present and future motors and generators.

C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner, or Contractor.

D. If applicable, include fault contribution of existing motors in the study. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

2.3 SHORT-CIRCUIT ANALYSIS

A. Transformer design impedances shall be used when test impedances are not available.

B. Provide the following:
   1. Calculation methods and assumptions
   2. Selected base per unit quantities
   3. One-line diagram of the system being evaluated that clearly identifies individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location and other information pertinent to the computer analysis
   4. The study shall include input circuit data including electric utility system characteristics, source impedance data, conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, motor contributions, and other circuit information as related to the short-circuit calculations.
   5. Tabulations of calculated quantities including short-circuit currents, X/R ratios, equipment short-circuit interrupting or withstand current ratings and notes regarding adequacy or inadequacy of the equipment rating.
   6. Results, conclusions, and recommendations. A comprehensive discussion section evaluating the adequacy or inadequacy of the equipment must be provided and include recommendations as appropriate for improvements to the system.

C. For solidly-grounded systems, provide a bolted line-to-ground fault current study for applicable buses as determined by the engineer performing the study.

D. Protective Device Evaluation:
   1. Evaluate equipment and protective devices and compare to short circuit ratings
2. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses
3. The electrical contractor shall notify the Engineer in writing, of any circuit protective devices improperly rated for the calculated available fault current.

2.4 PROTECTIVE DEVICE TIME-CURRENT COORDINATION ANALYSIS

A. Protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.

B. Include on each TCC graph, a complete title with descriptive device names.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.

D. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the TCC graphs, where applicable:
   1. Electric utility's overcurrent protective device
   2. Medium voltage equipment overcurrent relays
   3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
   4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
   5. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves
   6. Medium voltage conductor damage curves
   7. Ground fault protective devices, as applicable
   8. Pertinent motor starting characteristics and motor damage points, where applicable
   9. Pertinent generator short-circuit decrement curve and generator damage point
   10. The largest feeder circuit breaker in each motor control center and applicable panelboard.

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

G. Provide the following:
   1. A One-line diagram shall be provided which clearly identifies individual equipment buses, bus numbers, device identification numbers and the maximum available short-circuit current at each bus when known.
   2. A sufficient number of log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected overcurrent devices and other pertinent system parameters.
   3. Computer printouts shall accompany the log-log plots and will contain descriptions for each of the devices shown, settings of the adjustable devices, and device identification
numbers to aid in locating the devices on the log-log plots and the system one-line diagram.

4. The study shall include a separate, tabular printout containing the recommended settings of all adjustable overcurrent protective devices, the equipment designation where the device is located, and the device number corresponding to the device on the system one-line diagram.

5. A discussion section which evaluates the degree of system protection and service continuity with overcurrent devices, along with recommendations as required for addressing system protection or device coordination deficiencies.

6. The contractor shall notify the Engineer in writing of any significant deficiencies in protection and/or coordination. Provide recommendations for improvements.

PART 3 - EXECUTION

3.1 FIELD ADJUSTMENT

A. Contractor shall adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the Electrical Contractor.

B. Contractor shall make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. The Contractor shall notify the Engineer in writing of any required major equipment modifications.

END OF SECTION 260055
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SECTION 26 00 60 – ELECTRICAL SERVICE

PART 1 - GENERAL

1.1 SUMMARY

A. This section covers the electrical service from local utility.

B. Service shall be as follows:
   1. Pole mount transformer with underground secondary service.

1.2 RELATED SECTIONS

A. Refer to other sections for conductors, switchboards, and raceways, fittings and boxes.

1.3 UTILITY SERVICE FOR HOUSE #1

A. Verify all details relative to the Utility Company’s installation and termination requirements.
   Furnish and install all such material required by the Utility Company.

B. The building service voltage shall be 208 volts, 3 phase, 4 wire.

C. The Utility is Ameren.

1.4 UTILITY SERVICE FOR HOUSE #2

A. Verify all details relative to the Utility Company’s installation and termination requirements.
   Furnish and install all such material required by the Utility Company.

B. The building service voltage shall be 120/240 volts, 1 phase, 3 wire.

C. The Utility is Ameren.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 POLE MOUNTED TRANSFORMER WITH UNDERGROUND SECONDARY SERVICE

A. Electrical contractor shall

1. Furnish and install underground secondary service conduit including service conductors from the transformer pole to the service power meter and on into the service panelboard or directly on to the service panelboard or switchboard. The conduit shall be schedule 40 PVC with pull string at a minimum depth of three (3) feet. Provide a galvanized heavy wall long sweep elbow with 10'-0” conduit riser at pole. Offset the riser 4” to 6” from the pole to allow for mounting brackets. Also include a heavy wall long sweep elbow at the CT cabinet / meter. Include adequate surplus service conductors at the pole base in order to reach the pole mounted transformer, for utility connection.

2. Furnish and install the CT cabinet and meter socket which meets utility’s standards.

3. If meter is separate from service panelboard, provide service conductors from meter to service panel and grounding conductor for meter.
4. Install the utility-furnished current transformers and meter wiring harness.

B. The Utility Shall:

1. Furnish and install the pole-mounted transformer, pole and overhead line work.
2. Make terminations at the transformer.
3. Furnish and install the meter.
4. Make line side terminations in the meter or furnish the current transformers and meter wiring harness.
5. Furnish and install meter ground cable and ground rod for meter.

END OF SECTION 260060
SECTION 26 00 70 – ELECTRICAL CONNECTIONS FOR EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This section covers electrical connections to equipment.

1.2 EQUIPMENT CONNECTIONS

A. Extent of electrical connections for equipment is indicated by drawings and schedules. Electrical connections are hereby defined to include connections used for providing electrical power to equipment.

B. Refer to drawings for additional requirements.

C. Applications of electrical power connections specified in this section include the following:
   1. From electrical source to motor starters/VFDs.
   2. From motor starters/VFDs to motors.
   3. From electrical source to equipment with pre-wired control panels.

D. Provide electrical connections for equipment, specified in Division 21, 22, & 23 and in other Division 26 sections.

E. Provide motor starters and controllers, not furnished as part of equipment.

F. Refer to Motor and Equipment Schedule on drawings and Division 21, 22, & 23 sections for motor starters and controllers furnished with equipment.

G. Provide disconnect switches and junction boxes required for connecting motors and other electrical units of equipment.

H. Variable Frequency Drives (VFD) will be furnished under Division 22 & 23. Install VFDs and provide wiring and connections. Include wiring between VFD and safety switch to shut down VFD when safety switch is turned off and circuit is open.

I. Provide electrical identification for wire/cable conductors.

J. Provide raceways and wires/cables required for connecting motors and other electrical units of equipment.

K. Temperature control system wiring will be provided under Division 23.

L. Provide electrical work for kitchen equipment as described herein, and as indicated on the drawings.

M. Refer to sections of other divisions for specific individual equipment power requirements requiring electrical connections.

1.3 QUALITY ASSURANCE
A. ANSI Compliance: Comply with applicable requirements of ANSI/NEMA and ANSI/EIA standards pertaining to products and installation of electrical connections for equipment.

B. U.L. Compliance: Comply with U.L. Std. 486A, “Wire Connectors and Soldering Lugs for Use with Copper Conductors” including, but not limited to, tightening of electrical connectors to torque values indicated. Provide electrical connection products and materials which are U.L. listed and labeled.

C. Comply with NFPA 70 “National Electrical Code” for components and installation.

PART 2 - PRODUCTS

2.1 Provide products, components and materials which are listed and labeled by UL.

PART 3 - EXECUTION

3.1 ELECTRICAL WORK FOR KITCHEN EQUIPMENT

A. Provide all material and labor to install the electrical service and systems as required to operate the food service equipment. Make the final connections from the rough-in points to the connection points on the food service equipment.

B. Provide all wire, junction boxes, convenience outlets, switches, disconnects, starters, receptacles and pull boxes not built into the equipment.

C. Provide interconnecting wiring between the exhaust hood fire suppression system and the building fire alarm system.

D. Provide wiring to the make-up air unit. See hood drawings and/or HVAC drawings for locations and capacities. Provide motor starters, disconnects and furnish and install all fan and make-up air unit control and interlock wiring.

3.2 INSPECTION

A. Inspect area and conditions under which electrical connections for equipment are to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.3 INSTALLATION OF ELECTRICAL CONNECTIONS

A. Install electrical connections as indicated, in accordance with equipment manufacturer’s written instructions and with recognized industry practices and complying with applicable requirements of U.L., NEC and NECA’s “Standard of Installation” to ensure that products fulfill requirements.

B. Coordinate with other work, including wire/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.

C. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer’s written instructions and wiring diagrams. Mate and match
conductors of electrical connections for proper interface between electrical power supplies and installed equipment.

D. Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating than, the electrical insulation rating of those conductors being spliced.

E. Prepare cables and wires by cutting and stripping covering armor, jacket and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid “ringing” copper conductors while skinning wire.

F. Trim cables and wires as short as practicable and neatly arrange routing to facilitate inspections, testing and maintenance.

G. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer’s published torque tightening values for equipment connectors. Accomplish tightening by utilizing proper torqueing tools, including torque screwdriver, beam-type torque wrench and ratchet wrench with adjustable torque settings. Where manufacturer’s torqueing requirements are not available, tighten connectors and terminals to comply with torqueing values contained in U.L’s 486A.

H. Provide flexible conduit for motor connections and other electrical equipment connections, where subject to movement and vibration.

I. Provide liquid-tight flexible conduit for connection of motors and other electrical equipment where subject to movement and vibration, and also where connections are subjected to one or more of the following conditions:

1. Exterior location
2. Moist or humid atmosphere where condensate can be expected to accumulate
3. Corrosive atmosphere
4. Water spray
5. Dripping oil, grease or water
6. Kitchens or Dishwash areas

J. Fasten identification markers to each electrical power supply wire/cable conductor which indicates their voltage, phase and feeder number in accordance with Division 26, Sections 260010 and 260120, Part 3.4. Affix markers on each terminal conductor, as close as possible to the point of connection.

3.4 FIELD QUALITY CONTROL

A. Upon completion of installation of electrical connections, and after circuitry has been energized with rated power source, test connections to demonstrate capability and compliance with requirements. Ensure that direction of rotation of each motor fulfills requirement. Correct malfunctioning units at site, then retest to demonstrate compliance.

END OF SECTION 260070
SECTION 26 01 15 – UNDERGROUND DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.

1.2 SUMMARY
   A. This section covers the installation of direct bury and concrete encased underground ducts.

1.3 QUALITY ASSURANCE
   A. Comply with NFPA 70 “National Electrical Code” for components and installation.
   C. Listing and Labeling: Provide products specified in this Section that are UL listed and labeled.
   D. Comply with NECA / NEMA 605, “Recommended Practice for Installing Underground Non-metallic Utility Duct.”

PART 2 - PRODUCTS

2.1 LOW VOLTAGE POWER SYSTEMS (600V OR LESS)
   A. Provide PVC Schedule 40 ducts, direct buried or concrete encased, as indicated on plans.

2.2 CONNECTORS AND COUPLINGS
   A. Provide proper connectors and couplings for the ducts per manufacturer’s recommendations.

2.3 CONCRETE
   A. 3000 psi minimum 28 day compressive strength. Comply with American Concrete Institute Publications.

PART 3 - EXECUTION

3.1 COORDINATION
   A. Coordinate all locations, size and details of this installation with the existing site conditions.
   B. Work with extreme care near existing ducts, conduits, cables and other utilities to avoid damaging them.

3.2 INSTALLATION
   A. Clearances between each conduit and/or duct shall not be less than 3 inches.
   B. Install concrete or plastic spacers to insure maintenance of the above clearances during concrete pours.
C. Install tie wires to prevent displacement of the ducts and conduits during pouring of concrete. Do not use tie wires as substitutes for the spacers.

D. Prior to installing cables in new and existing underground raceways, thoroughly clean the raceways with suitable mandrels or swabs.

3.3 TERMINATIONS

A. Terminate the ducts and conduits with the proper manufactured end bells.

B. Seal the ducts and conduits at building entrances and at outdoor terminations for equipment, including spare ducts and conduits, with a suitable compound to prevent the entrance of moisture and gases. Install Tyco Electronics “TDUX” or equivalent product in all conduits at building entrance.

C. Where new ducts, conduits and concrete envelopes are to be joined to existing manholes, hand holes, ducts, conduits and concrete envelopes, make the joints with the proper fittings and fabricate the concrete envelopes to insure smooth, durable transitions.

3.4 TRENCHES

A. Cut the trenches neatly and uniformly.

B. Pitch the trenches uniformly without pockets, not less than 4 inches per 100 feet, toward manholes or both ways from high points between manholes. Avoid pitching the ducts toward buildings wherever possible.

3.5 CONCRETE WORK

A. Concrete envelopes, when indicated, shall be as follows:

1. Shall extend not less than 3 inches beyond the outside walls of the outer ducts and conduits.

2. Top not less than 24 inches below finished grade in lawn and other non-paved areas.

3. Top not less than 30 inches below finished grade at roads and other paved surfaces.

B. Pour concrete beds in the trenches, not less than 3 inches thick, and allow the concrete to set before placing the ducts or conduits.

END OF SECTION 260115
SECTION 26 01 20 - CONDUCTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.

1.2 SUMMARY

A. This section includes conductors, wires, cables and associated splices, connections and terminations for wiring systems rated 600V or less.

1.3 QUALITY ASSURANCE

A. Conductors and cable shall conform to UL, NEMA WC70, NECA 120, NFPA 70 and ICEA S-95-658 requirements.

B. Comply with NECA 120, “Standard for Installing Armored Cable (Type AC) and Metal Clad Cable (Type MC).”


PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Wires and Cables

1. Alcan Products Corporation; Alcan Cable Division
3. BICC Brand-Rex Company
4. Carol Cable Co., Inc.
5. Service Wire Company
6. Southwire Company
7. Alflex Corporation
8. AFC Cable Systems, Inc.
9. Colonial Wire and Cable Co., Inc.
10. General Cable Corporation
11. Okonite Company
12. Pirelli Cable Company
13. Superior Essex

B. Connectors for Wires and Cables

1. AMP Inc.
2. General Signal; O-Z/Gedney Unit
3. Tyco Electronics Corporation
4. Square D Co.; Anderson
5. 3M Company; Electrical Products Division
6. AFC Cable Systems, Inc.
7. Erico, Inc.
9. ILSCO Corporation
10. Thomas & Betts Corporation

2.2 CONDUCTORS

A. Provide copper conductors with insulation rated for 600 volts, type THHN or THWN for interior use and type XHHW-2 for exterior installation.

B. Conductors No. 10 AWG and smaller shall be solid. Conductors No. 8 AWG and larger shall be stranded.

C. Provide single copper conductors throughout. Provide No. 12 AWG minimum branch circuit wire size. Provide No. 14 AWG for control circuits, unless otherwise specified or required by overcurrent protection.

D. For exterior feeders or branch circuits, provide Type XHHW-2 conductors installed in underground raceways.

2.3 CONNECTORS FOR CONDUCTORS

A. Provide UL-listed factory-fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types and classes for application and for service indicated. Use connectors with temperature ratings equal to or greater than those of the wires upon which used.

2.4 CABLES

A. Type MC cable shall be THHN/THWN insulated circuit conductors with full size insulated ground wire enclosed within flexible metal covering. Metal covering shall be galvanized steel.

B. Type AC cable shall have THHN/THWN insulated circuit conductors with bonding conductor enclosed with flexible metal covering. Metal covering shall be galvanized steel.

C. Connectors and fittings for type MC and type AC cable shall be manufactured and listed for that purpose.

2.5 TYPE NOT PERMITTED

A. The following wire and cable types are not permitted to be used:

1. BX
2. NM/NME
3. TW

PART 3 - EXECUTION

3.1 CONDUCTOR SIZES AND TYPES

A. Low voltage wire and cable for audio, signal and control cables are specified elsewhere in this Specification.
B. Any 120V lighting and receptacle circuit, whose home run length from panel to first fixture or device exceeds one hundred (100) feet for 120V circuits, shall not be less than 10 gauge for the entire length of run, to minimize voltage drop.

C. Wire size and insulation type entering any lighting fixture or equipment shall be as recommended by the manufacturer and as minimally required by the codes. Where no recommendation is given by the manufacturer, the wire size and insulation type shall meet the minimum rating of the wiring or terminations used in the fixture or equipment.

D. Conductor sizes for motors, equipment and feeders shall be as indicated. See Schedules on drawings.

E. Type AC cable may be used only for flexible connections to recessed lighting fixtures from separately mounted outlet boxes. Length shall not exceed six feet.

F. Type MC cable may be used only for flexible wiring from outlet boxes mounted above accessible ceilings to wall switches and wall mounted 120V duplex receptacles. Junction box where flexible cable starts shall be part of branch circuit conduit system located in accessible ceiling space. MC cable shall not be used for homeruns. Use EMT conduit for all homeruns and connection to Electrical Panels.

3.2 INSTALLATION

A. Wire and cable shall be installed in conduit, duct, wireway, surface raceway or other raceway specified. No conductors or cables shall be installed in conduits, ducts or raceways until the raceway system has been completed and free of any dirt or water. When installing conductors, exercise due care to prevent damage to conductors and insulation.

B. Wire 10 gauge or smaller shall be spliced, tapped or joined in outlet or junction boxes with solderless spring-type connectors. Bakelite insulated wire nuts are not approved.

C. Conductors 8 gauge and larger shall be terminated using bolted pressure or compression type connectors. They shall be specifically designed for use with the type conductors being installed in compliance with manufacturer’s recommendations.

D. Uninsulated splices, joints and free ends of conductors shall be covered with rubber and friction tape or high dielectric polyvinylchloride Scotch No. 33 Plus electrical tape.

E. Feeder cables shall be continuous from origin to panel or equipment termination without splices in intermediate pull or splice boxes or raceway runs. Where taps and splices are necessary, they shall be made in approved splice boxes with suitable compression type connectors.

F. Fixture and branch circuit wiring joints in exterior junction and outlet boxes shall be made with waterproof connectors rated at 600 volts maximum (1,000 volts when enclosed in fixture or sign).

G. Exterior branch circuit conductor splices below grade shall occur only in gasketed weatherproof junction boxes. Use split bolt connector with Okonite self-fusing tape #35, wrapped by Scotch #33 Plus tape and sealed with 3M High Gel Re-enterable Encapsulant #8882.
H. Coordinate wire installation with other work. Support cables in accordance with Section 260190.

I. Pull conductors simultaneously where more than one is being installed in same raceway. Use UL listed pulling compound or lubricant, where necessary. Perform pull tension calculations and do not exceed those values.

J. Use pulling means including fish tape, cable, rope and basket weave wire/cable grips which will not damage cable or raceways. Do not use rope hitches for pulling attachment to wire or cable. Do not exceed manufacturer’s recommended maximum pulling tensions and sidewall pressure values.

K. Keep conductor splices to a minimum. Provide splice and tap connectors which possess better mechanical strength and insulation rating than conductors being spliced. Use splice and tap connectors which are compatible with conductor materials.

L. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Make terminations so there is no bare conductor at the terminal. Bundle conductor sizes #12 and #10 together. Bundle individual circuits larger than #10 separately.

M. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer’s published torque tightening values. Where manufacturer’s torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and UL 486B.

N. Connect wiring devices, light fixtures, panelboard devices and other electrical equipment to the wiring systems as indicated and in accordance with manufacturer’s instructions.

O. Leave a minimum of 12" pigtail at each outlet for termination purposes.

P. Home runs shall be in conduit. Not more than three (3) branch circuits may be grouped in one (1) homerun to a branch circuit panelboard. Derate conductors per NEC requirements and count the neutral as a current carrying conductor.

Q. Through-wiring is not permitted for recessed lighting fixtures. Each recessed lighting fixture shall be connected by flexible metal-clad cable to a separate junction box mounted above ceiling, which may serve no more than four fixtures. This flexible cable shall be Type MC or AC cable, with ground.

R. Through-wiring is permitted for continuous rows of surface-mounted or pendant-mounted light fixtures. Fixture rows, pendant or surface-mounted, shall be fed through a flush ceiling-mounted outlet box. Branch circuit conductors for through-wiring shall have a minimum temperature rating of 90°C, or higher, if required by lighting fixture manufacturer.

S. Install conductors with compression type motor pigtail connectors of sizes as required for motors and mechanical equipment. Connectors shall be rated for 600V, 90 degrees C, and tin plated copper with the thermoplastic elastomer insulator.

T. Where lugs or termination points are not sized to accommodate the wire size specified or are not listed for the conductor material, provide pin connectors rated for use with
copper/aluminum conductors and terminate with a tool and die size recommended by the connector manufacturer.

U. Keep emergency conductors independent and separate from all other conductors. Do not route emergency conductors and normal conductors in the same raceway.

3.3 FIELD QUALITY CONTROL

A. Prior to energizing, check installed wires and cables with megohm meter to determine insulation resistance levels to assure requirements are fulfilled. Visually inspect all terminations are tight and proper and materials installed are in accordance with the specification section.

B. Prior to energizing test wires and cables for electrical continuity and for short-circuits and proper phase relationship. Verify conductors are appropriately color coded.

C. Subsequent to wire and cable hook-ups, energize circuits and demonstrate proper functioning. Correct malfunctioning units, and retest to demonstrate compliance.

D. Torque all connections/lugs in accordance with manufacturer instructions. Where torque valves are absent, follow ANSI/NETA Standard for acceptance testing specifications.

3.4 COLOR CODING FOR PHASE IDENTIFICATION

A. Color code secondary service, feeder and branch circuit conductors with factory applied color as follows:

<table>
<thead>
<tr>
<th>208Y/120 Volts</th>
<th>Phase</th>
<th>480Y/277 Volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>A</td>
<td>Yellow</td>
</tr>
<tr>
<td>Red</td>
<td>B</td>
<td>Brown</td>
</tr>
<tr>
<td>Blue</td>
<td>C</td>
<td>Orange</td>
</tr>
<tr>
<td>White</td>
<td>Neutral</td>
<td>White/Gray Stripe</td>
</tr>
<tr>
<td>Green</td>
<td>Ground</td>
<td>Green</td>
</tr>
</tbody>
</table>

B. Where the local jurisdiction requires, color code 480Y/277 phase C conductor purple.

C. Phase conductors with special marking, such as in type MC cable assemblies, shall be acceptable.

D. Conductors manufactured in only one color shall be marked with colored tape at each termination to identify each conductor as phase, neutral or ground.

E. Ungrounded conductors supplied from more than one nominal voltage system shall be separately identified where accessible.

END OF SECTION 260120
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SECTION 26 01 40 – WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This section covers wiring devices, including floor boxes and outlets, and multi-outlet surface metal raceways.

1.2 RELATED DOCUMENTS

A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.

1.3 RELATED SECTIONS

A. Provide boxes and raceways as specified in Section 260110 - RACEWAYS, FITTINGS AND BOXES.

1.4 QUALITY ASSURANCE

A. Wiring devices shall comply with NEMA Standards WD-1 and WD-6.

B. Comply with NECA 130, “Standard for Installing and Maintaining Wiring Devices.”

PART 2 - PRODUCTS

2.1 SWITCHES

A. Switches shall be specification grade, quiet operating type rated 120/277V, 20 amperes, color as selected by architect, types as listed below:

<table>
<thead>
<tr>
<th>Type</th>
<th>HUBBELL</th>
<th>COOPER</th>
<th>P&amp;S</th>
<th>LEVITON</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Pole</td>
<td>CSB120-*</td>
<td>2221</td>
<td>PS20AC1-*</td>
<td>1221-2*</td>
</tr>
<tr>
<td>Double Pole</td>
<td>CSB220-*</td>
<td>2222</td>
<td>PS20AC2-*</td>
<td>1222-2*</td>
</tr>
<tr>
<td>Three Way</td>
<td>CSB320-*</td>
<td>2223</td>
<td>PS20AC3-*</td>
<td>1223-2*</td>
</tr>
<tr>
<td>Four Way</td>
<td>CSB402-*</td>
<td>2224</td>
<td>PS20AC4-*</td>
<td>1224-2*</td>
</tr>
<tr>
<td>Key-Single Pole</td>
<td>HBL1221L</td>
<td>2221L</td>
<td>PS20AC1*L</td>
<td>1221-2L</td>
</tr>
<tr>
<td>Pilot Light (1P)</td>
<td>HBL1221PLC</td>
<td>2221-PL</td>
<td>PS20AC1CPL</td>
<td>1221-PL</td>
</tr>
</tbody>
</table>

B. Switches shall comply with UL Standard 20, and with Federal Specification W-S.

C. Manufactured modular connector devices equivalent to Pass Seymour Plug Tail shall be acceptable.

2.2 SWITCHES ON EMERGENCY CIRCUITS

A. Switches shall be specification grade, quiet operating type rated 120/277V, 20 amperes, red color, types as listed below:

<table>
<thead>
<tr>
<th>Type</th>
<th>HUBBELL</th>
<th>COOPER</th>
<th>P&amp;S</th>
<th>LEVITON</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Pole</td>
<td>CSB120R</td>
<td>2221-RD</td>
<td>PS20AC1-RED</td>
<td>1221-R</td>
</tr>
<tr>
<td>Double Pole</td>
<td>CSB220R</td>
<td>2222-RD</td>
<td>PS20AC2-RED</td>
<td>1221-R</td>
</tr>
</tbody>
</table>
B. Manufactured modular connector devices equivalent to Pass Seymour Plug Tail shall be acceptable.

2.3 WALL DIMMERS

A. Dimmers shall be specification grade UL Listed (File #E-47967), designed for the demands of a commercial application.

Cooper SKYE SF10P-W 1200W LED
Leviton MNI10-1LW 1000W Incandescent
Leviton MNI15-1LW 1500W Incandescent
Leviton MMN06-1LW 600VA Magnetic Low Voltage
Leviton MMN10-1LW 1000VA Magnetic Low Voltage
Leviton MMN15-1LW 1500VA Magnetic Low Voltage
Leviton MNX10-1LW 1000VA 120 volt fluorescent dimming
Leviton MNX15-1LW 1500VA 120 volt fluorescent dimming
Leviton MNX20-7LW 2000VA 277volt fluorescent dimming
Leviton MNX30-7LW 3000VA 277volt fluorescent dimming

2.4 RECEPTACLES

A. Receptacles shall be NEMA 5-20R, grounding type, rated 20 amperes, 125 volt, color as selected by architect (provide gray for WP cover plates), types as listed below:

<table>
<thead>
<tr>
<th>Type</th>
<th>HUBBELL</th>
<th>COOPER</th>
<th>P&amp;S</th>
<th>LEVITON</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duplex</td>
<td>HBL5362-*</td>
<td>5362*</td>
<td>5362-A*</td>
<td>5362-*</td>
</tr>
<tr>
<td>Single</td>
<td>HBL5361-*</td>
<td>5361*</td>
<td>5361-*</td>
<td>5361-*</td>
</tr>
<tr>
<td>Ground Fault</td>
<td>GFST20*</td>
<td>VG F20*</td>
<td>2096*</td>
<td>S7899-*</td>
</tr>
<tr>
<td>Ground Fault Tamper</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resistant</td>
<td>GFR5362SG*</td>
<td>---</td>
<td>2096TR*</td>
<td>S7899-*</td>
</tr>
<tr>
<td>(Ground fault receptacle shall be of self-test diagnostic with red and green indicator lights.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ground Fault Weather</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resistant</td>
<td>GFR5362SG*</td>
<td>---</td>
<td>2095TRWR*</td>
<td>WT899-KW*</td>
</tr>
<tr>
<td>Duplex Tamper Resistant</td>
<td>HBL8300SG*-A</td>
<td>---</td>
<td>TR5362*</td>
<td>SG63H-*</td>
</tr>
<tr>
<td>Duplex Isolated Ground</td>
<td>IG5362*</td>
<td>IGS362RN</td>
<td>IG5362*</td>
<td>IG5362</td>
</tr>
</tbody>
</table>

B. Manufactured modular connector devices equivalent to Pass Seymour Plug Tail shall be acceptable.

C. Receptacles with USB charger shall be rated 20A circuit feed through, 125V, color as selected by architect (provide decorator type cover plate.) USB charger rated 5A, 5VDC.

Duplex with USB Charger: HUBBELL Cat #: US20AC5W.

D. Dryer receptacle shall be NEMA 14 30R grounding type, rated 30 amperes, 3 pole, 4 wire, 125/250 volt black color, types as listed below.
E. Range receptacle shall be NEMA 14-50R grounding type, rated 50 amperes, 3 pole, 4 wire, 125/250 volt black color types as listed below:

<table>
<thead>
<tr>
<th></th>
<th>HUBBELL</th>
<th>COOPER</th>
<th>P&amp;S</th>
<th>LEVITON</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dryer Outlet</td>
<td>RR430F</td>
<td>1257</td>
<td>3864</td>
<td>278</td>
</tr>
<tr>
<td>Range Outlet</td>
<td>RR450F</td>
<td>1258</td>
<td>3894</td>
<td>279</td>
</tr>
</tbody>
</table>

F. Receptacles shall comply with UL Standard 498 Federal Specification WC596F.

2.5 RECEPTACLES ON EMERGENCY CIRCUITS

A. Receptacles shall be NEMA 5-20R, grounding type, rated 20 amperes, 125 volt, red color, types as listed below:

<table>
<thead>
<tr>
<th></th>
<th>HUBBELL</th>
<th>COOPER</th>
<th>P&amp;S</th>
<th>LEVITON</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duplex</td>
<td>HBL5362-R</td>
<td>5362-RD</td>
<td>5362ARED</td>
<td>5362-R</td>
</tr>
<tr>
<td>Single</td>
<td>HBL5361-R</td>
<td>---</td>
<td>5361RED</td>
<td>5361-R</td>
</tr>
<tr>
<td>Ground Fault</td>
<td>GF202RLA</td>
<td>---</td>
<td>2095RED</td>
<td>EQUIVALENT</td>
</tr>
<tr>
<td>Duplex Tamper Resistant</td>
<td>BR20ITR</td>
<td>---</td>
<td>TR5362RED</td>
<td>6898HG-R</td>
</tr>
</tbody>
</table>

B. Manufactured modular connector devices equivalent to Pass Seymour Plug Tail shall be acceptable.

2.6 COVERPLATES

A. Provide coverplates of the appropriate type and size on all devices.

B. Coverplates shall be the same color as the device, smooth thermoplastic nylon, as manufactured by Cooper, P&S, Hubbell or Leviton.

C. Receptacles and coverplates for emergency outlets shall be red.

D. Switches and coverplates for emergency circuits shall be red.

E. Device plates that will contain pilot lights shall be metal, smooth, jumbo type.

F. Where devices are installed in exposed fittings or boxes, use Appleton "FSK" covers.

G. Install blank covers on boxes without devices.

H. Weatherproof Cover Plates (WP Designation)

1. Receptacles in Damp Locations shall have an enclosure for the receptacle that is weatherproof when the receptacle is covered (attachment plug cap not inserted and receptacle covers closed).

2. Receptacles in Wet Locations shall have an enclosure that is weatherproof whether or not the attachment plug cap is inserted. An outlet box hood installed for this purpose shall be listed and shall be identified as “extra-duty”.

19-2726.01 & 19-2727.01
4. Horizontal Mounting: Cast aluminum, mounted on FS/FD box, suitable for GFI receptacle: TayMac MX3300, Hubbell WP26M, P & S WIUC10CABRH, Cooper WIUMH-1W.

2.7 SPECIAL USE OUTLETS

   A. Floor outlets:
      1. Single power flush rectangular floor outlet for 120 volt duplex receptacle shall be Hubbell S-3825 flush brass cover with B 2421 rectangular steel box in concrete floor above grade. Floor outlet on grade requires B 2436 cast box or equivalent from wiremold or Thomas and Betters. Confirm with engineer for precise depth of floor thickness.
      2. Floor outlets shall be provided with metal carpet flanges when installed in areas that have a carpet finish as manufactured by Hubbell for the boxes called out above color shall match coverplate.

   B. Provide special purpose outlets as indicated on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

   A. Install devices and assemblies plumb and secure.
   B. Install wall plates when painting is complete.
   C. Arrangement of Devices: Except as otherwise indicated, mount flush, with long dimension vertical and grounding terminal of receptacles on top. Group adjacent devices under single, multi-gang wall plates.
   D. Protect devices and assemblies during painting.
   E. Adjust location where floor service outlets and telephone/power service poles are installed to suit the indicated arrangement of partitions and furnishings.
   F. Receptacles shall be repositioned not more than 10 feet from location indicated, when so directed by the Architect, at no cost to the owner.
   G. Barriers: Provide compartment and/or outlet box barriers between device for the following conditions:
      1. Where devices, receptacles or switches are served by normal and emergency power sources.
      2. Where devices operate at different voltage.
   H. Install exterior GFI receptacles horizontally, with weatherproof cover plate.

3.2 MOUNTING HEIGHTS TO CENTERLINE OF DEVICE

   A. Receptacles: 18" above floor.
B. Wall switches: 46" above floor.
C. Counter Receptacles: 6" above back splash.

3.3 GROUNDING
A. Receptacle ground terminal: Connect ground terminal to grounding conductor routed with circuit conductors.

3.4 FIELD QUALITY CONTROL
A. Testing: Test wiring devices for proper polarity and ground continuity.
B. Test ground-fault circuit interrupter operation according to manufacturer recommendations.
C. Replace damaged or defective components.

3.5 CLEANING
A. General: Internally clean devices, device outlet boxes and enclosures. Replace stained damaged or improperly painted wall plates or devices. Devices with drywall mud, spackle, and caulk, adhesive or other foreign material shall be considered damaged and replaced.

END OF SECTION 260140
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SECTION 26 01 50 - MOTORS AND MOTOR CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.

B. This section covers motors and motor control devices.


PART 2 - PRODUCTS

2.1 GENERAL

A. Unless otherwise indicated, all motors 3/4 horsepower and larger shall be connected for operation at 208 volts or 480 volts, 3 phase, and motors less than 3/4 horsepower shall be connected for operation at 115 volts, single phase.

B. Motors. All motors shown on the drawings will be furnished and set in place under the respective section where the equipment is specified.

C. Motor Controls. Unless specifically indicated otherwise, provide all power wiring, disconnects, starters, relays, pushbuttons, pilot lights, motor connections, supports, and all appurtenances required for the safe and satisfactory control of all motors.

D. Refer to the Motor Equipment Schedule on the drawings for details.

2.2 MOTOR STARTERS

A. Provide magnetic starters for three-phase motors. Provide manual starters for single-phase motors unless otherwise indicated. NEMA 1 enclosure is standard, but for enclosures exposed to the weather provide NEMA 3R enclosures. Square D starters are specified to establish quality and general requirements. Comparable starters manufactured by Siemens, Eaton or General Electric will be acceptable.

B. In each magnetic starter provide:

1. Cover-mounted "Start" button, cover-mounted "Hand-Off-Automatic" selector switch or "Start-Stop" pushbutton as shown on Motor Control Schedule, and manual overload reset button.
3. One solid state overload relay with adjustable trip setting properly sized for the actual motor nameplate current and motor operating conditions. Multiply by 1.15 for 1.15 service factor motor. Solid state relay shall have phase loss, phase unbalance protection and shall be ambient temperature insensitive. Use heater type overload relays only in open delta or ground “B” phase systems.
4. Minimum of two auxiliary contacts plus those scheduled (maximum 4).
5. Control transformer (unless otherwise indicated) for maximum control voltage of 120 VAC complete with primary and secondary overcurrent and short circuit protection.

C. Manual Motor Starters. Provide Square D, Class 2510, 2511, 2512, single pole, complete with red "On" pilot light, toggle switch, overload relay, and manual overload reset. Provide flush mounting with stainless steel plate in finished areas and surface mounting in unfinished areas. The starter shall have a minimum rating of 1 horsepower at 240 VAC.

D. Full Voltage Magnetic Starter. Provide Square D, Class 8538, non-reversing, sized for the horsepower and current rating of the motor. The minimum size shall be NEMA size 0.

E. Combination Starters
   1. For indoor application, provide Square D, Class 8538 with fused or non-fused disconnect as indicated.
   2. For outdoor application, provide Square D, Class 8538(NEMA 3R) with fused or non-fused disconnect as indicated.

F. Remote controls. Provide Square D, Class 9001, 22mm pushbuttons and selector switches, oil tight type, with red "ON" pilot light. Provide flush mounting with stainless steel plate in finished areas and surface mounting in unfinished areas. Provide momentary "Start-Stop" buttons or maintained contact three-position "Hand-Off-Automatic" selector switch, as indicated.

PART 3 - EXECUTION

3.1 Coordinate all details pertaining to the motor control equipment with the mechanical and temperature control installation. This includes, but is not limited to: motor size, coordination of motor starter coil voltage ratings, verification and coordination of mechanical control device voltage and amp ratings, and coordination of pilot control devices such as momentary contact versus maintained contact.

3.2 All Temperature Control Wiring (below 100 VAC) will be provided by the Mechanical Contractor. All interlock wiring (100 VAC and above) shall be provided by the Electrical Contractor, unless otherwise indicated. See the Motor Schedule on the plans and Sequence of Controls Specification section 230965 for detailed requirements. In general, the interlock wiring is not shown on the plans, but is called out in the Motor Schedule or specifications. The Electrical Contractor is responsible for furnishing and installing all such control wiring as indicated on the Motor Schedule, even if not shown on the plans. The Electrical Contractor is also responsible for the proper electrical operation of all items on the Motor Schedule, such as correct rotation of motors, correct heater sizes, etc.

3.3 Provide all connections to motors, and other equipment subject to vibration, with a flexible conduit connection. Use jacketed weatherproof flexible conduit, equal to Sealtite, for motors installed in a damp or wet location. Flexible conduit shall be installed in sufficient length and with enough slack to preclude transmission of vibration.

3.4 All starters shall be installed less overload heaters. The Electrical Contractor shall review the motor nameplates for the full load amps. When all nameplate full load amps have been recorded, the overload heaters shall be ordered and installed. Any starters that are installed
with overload heaters prior to the nameplate full load amps being available shall, if required, be changed by the Electrical Contractor at no additional cost to the Owner.

END OF SECTION 260150
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SECTION 26 01 80 - LOW VOLTAGE FUSES - 600 VOLTS AND LESS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.

1.2 SUMMARY
   A. This section includes fuses for electrical systems operating at 600V or less.
   B. Provide fuses of the sizes and ratings shown on the drawings.

1.3 QUALITY ASSURANCE
   A. Comply with NFPA 70 “National Electrical Code” for components and installation.
   B. Comply with NEMA FU1.
   C. Comply with NECA 420, “Standard for Fuse Applications.”

1.4 SUBMITTALS
   A. Product Data: Manufacturer’s technical data on characteristics and ratings.
   B. Let-through current curves.
   C. Ambient temperature adjustment information and calculations

PART 2 - PRODUCTS

2.1 MANUFACTURER
   A. Provide fuses manufactured by Bussmann Manufacturing Division of Cooper Industries or equivalent from Mersen or Littelfuse.

2.2 FUSES
   A. All fuses for the distribution system shall be of the same manufacturer to ensure selective coordination. Fuses shall have a UL listed 200,000 ampere interrupting rating.
   B. Switchboards and panelboards shall not be shipped to the project with the fuses installed.
   C. Type of fuses to be used shall comply with the following, unless otherwise noted on the plans:
      1. Main, Feeders and Branch Circuits:
         a. 0 to 600 ampere - use Bussmann LOW PEAK YELLOW, UL Class RK-1, dual-element, time delay fuses.
            1) Type LPN-RK (amp) SP for 250 volts
            2) Type LPS-RK (amp) SP for 600 volts
b. or if the equipment has Class J fuse mountings, use Bussmann LOW PEAK YELLOW, Class J, dual-element, time delay fuses.
   1) Type LPJ (amp) SP

c. 601 to 6000 ampere - use Bussmann LOW PEAK YELLOW, UL Class L, time delay fuses, with pure silver links.
   1) Type KRP-C (amp) SP

2.3 SUBSTITUTION APPROVALS

A. The E.C.’s proposal shall be based upon the fuse specified using the manufacturer’s catalog numbers as called for in the specification or on the drawings. Coordination and current limitation for protection of each part of the electrical system has been designed around the type, class and manufacturer specified.

B. Different manufacturers’ fuses of the same UL classification can have different electrical performance and/or electrical characteristics. Therefore, multiple manufacturers will not be acceptable. Provide fuses from a single manufacturer throughout the project.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fuses shall not be installed until the electrical installation is complete, including thorough cleaning, tightening of all electrical connections, inspection of all grounding conductors, and a megger test for adequate installation to ground of all circuits.

B. Provide Bussmann metal fuse reducers where the fuses are smaller than the fuse clips.

C. Furnish spare fuses (minimum of three of each size and type) and place in the spare fuse cabinet.

D. A fuse identification label, showing type and size, shall be placed inside the door of each switch.

E. Install fuses in fusible devices and arrange so rating information is readable without removing fuse.

END OF SECTION 260180
SECTION 26 01 90 - SUPPORTING DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES
   A. Conduit and equipment supports.
   B. Anchors and fasteners.

1.2 RELATED DOCUMENTS
   A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.

1.3 REFERENCES
   A. NECA 101- “Standard for Installing Steel Conduit (Rigid, IMC, EMT).”
   C. Refer to 260025, SEISMIC RESTRAINTS Section for additional requirements.

PART 2 - PRODUCTS

2.1 Materials and Finishes: Provide adequate corrosion resistance.

2.2 Provide material, sizes and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products. System shall be adequate in tension, shear and pullout forces to resist maximum loads calculated or imposed with a minimum structural safety factor of four times the applied force. Minimum static design load shall be the weight of supported components, plus 200 lbs.

2.3 Anchors and Fasteners:
   A. Steel structural elements: Use beam clamps, spring steel clips, steel ramset fasteners, or welded fasteners.
   B. Concrete surfaces: Use self-drilling anchors and expansion anchors.
   C. Hollow Masonry, plaster, and gypsum board partitions: Use toggle bolts and hollow wall fasteners.
   D. Solid masonry walls: Use expansion anchors.

2.4 Steel strut framework: Provide 12 gauge minimum size framework similar and equivalent to B-line or Unistrut for supporting electrical enclosures where noted or where necessary for a rigid installation.

PART 3 - EXECUTION

3.1 INSTALLATION
   A. Install products in accordance with manufacturer’s instructions.
B. Provide anchors, fasteners, and supports in accordance with NECA “Standard of Installation”, NECA 1 and 101. Space supports as scheduled in NECA 1 where Table 1 lists maximum spacings less than those listed in NFPA 70.

C. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.

D. Do not drill or cut structural members.

E. Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.

F. Install surface-mounted equipment enclosures with minimum of four anchors.

G. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

H. Install trapeze-type supports fabricated with steel slotted support system. Secure raceways to supports with two-bolt conduit clamps.

I. Cast anchor bolts into concrete housekeeping bases and anchor equipment. Install anchor bolts per equipment manufacturer’s setting drawings, templates, diagrams, instructions and directions at required elevations.

END OF SECTION 260190
SECTION 26 04 32 – SERVICE PANELBOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.

1.2 SUMMARY

A. This Section includes low-voltage power service and distribution panelboards and associated auxiliary equipment rated 600 V or less.

1.3 QUALITY ASSURANCE

A. Provide panelboard assemblies that are listed and labeled as defined in the National Electrical Code, Article 100. Service Panelboards shall meet NEC Article 110 Requirements for Electrical Installation and Article 408 Switchboards and Panelboards.

B. Electrical Component Standard: Components and installation shall comply with NFPA 70, “National Electrical Code.”


D. UL Standard: Comply with UL 891, “Deadfront Panelboards.”

E. Comply with NECA 407, “Recommended Practice for Installing and Maintaining Panelboards.”

F. Product Selection for Restricted Space: The Drawings indicate dimensions for panelboard equipment including clearances between panelboard and adjacent surfaces and items. Provide panelboards which have equal performance characteristics and which comply with indicated dimensions.

G. Panelboard shall be UL listed and labeled for use as service entrance equipment.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.

B. Store so condensation will not occur on or in panelboards. Provide temporary heaters as required to assure avoiding condensation.


PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

19-2726.01 & SERVICE PANELBOARD 26 04 32 - 1
19-2727.01
1. Square D Co., Schneider Electric
2. Siemens Energy & Automation, Inc.
4. Eaton

B. FABRICATION

1. The panelboard framework shall be fabricated on a die-formed steel base or base assembly consisting of formed steel and commercial channel welded or bolted together to rigidly support the entire shipping unit for moving on rollers and floor mounting. Alternately, panel can be wall or strut mounted. The framework is to be formed code gauge steel, rigidly welded and bolted together to support all coverplates, bussing, and component devices during shipment and installation. Top and bottom conduit area is to be clearly shown and dimensioned on the shop drawings. Wireways, and sides and rear, shall have removable bolt-on or screw-on cover panels. The paint finish shall be gray enamel over a rust-inhibiting phosphate primer.

2. The panelboard bus shall be either copper or tin-plated aluminum of sufficient cross-sectional area to continuously conduct rated full load current with a maximum temperature rise of 65 degrees C. The bus bars shall have minimum short circuit bracing of 50,000 RMS amps symmetrical or as indicated on the one-line diagram. Neutral busses shall be the same size and material as the phase busses. Panelboard shall be provided with a copper ground bus, which shall be bonded to the panelboard enclosure.

2.2 ENCLOSURE

A. Type 1 building interior locations.

B. Sections shall be aligned front and rear. Front covers shall be hinged and latched with provisions for pad locking.

C. The panelboard enclosure shall be painted on all exterior surfaces. The paint finish shall be medium gray, ANSI #49, applied by the electro-deposition process over an iron phosphate pretreatment.

D. Provide with front covers that shall be screw removable with a single tool and all doors shall be hinged with removable hinge pins.

E. Top and bottom conduit areas shall be clearly indicated on shop drawings.

2.3 UTILITY METERING COMPARTMENT

A. The utility current transformers shall be located in a separate outdoor enclosure.

2.4 OVERCURRENT DEVICES

A. Switches 800 amperes and less shall be quick-make, quick-break and suitable for use on the service as described for the sizes as shown on the associated drawings. The units, where applicable, shall be horsepower rated for dual-element fuses. The fusible switches shall be group mounted in panel-type construction. Each switch is to be enclosed in a separate steel enclosure. The enclosure shall employ a hinged cover for access to the fuses which shall be
interlocked with the operating handle to prevent opening the cover when the switch is in the ON position. This interlock shall be constructed so that it can be released with a standard electrician's tool for testing fuses without interrupting service. The units shall have padlocking provisions in the OFF position and the operating handle position shall give positive position indication, i.e., horizontal OFF, diagonal ON.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents:

3. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (5-mA trip).
4. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
   a. Standard frame sizes, trip ratings, and number of poles.
   b. Lugs: Mechanical-type terminals shall be provided for all line and load terminations suitable for copper or aluminum cable rated for 75 degrees C of the sizes, number, ratings and conductor material as indicated on the drawings.
   c. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be non-welding silver alloy and arc extinction shall be accomplished by means of arc chutes. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.
   d. Each molded case circuit breaker microprocessor-based tripping system shall consist of three (3) current sensors, a trip unit and a flux-transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the adjustable time-current protection functions. True rms sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors, and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time-delay settings are reached.
   e. An adjustable trip setting dial mounted on the front of the trip unit, or interchangeable ratings plugs shall establish the continuous trip ratings of each circuit breaker. Rating plugs shall be fixed or adjustable as indicated. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.
   f. System coordination shall be provided by the following microprocessor-based time-current curve shaping adjustments:
1) Adjustable long-time setting (set by adjusting the trip setting dial or rating plug)
2) Adjustable short-time setting and delay with selective curve shaping
3) Adjustable instantaneous setting
4) Adjustable ground fault trip setting

g. The microprocessor-based trip unit shall have both powered and unpowered thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession.

h. Ground fault protection adjustable settings shall not exceed 1200 amperes. Provide neutral ground fault sensor for four-wire loads.

i. Breakers shall have built-in test points for testing the long-time delay, instantaneous, and ground fault functions of the breaker by means of a test set.

2.5 INSTRUMENTATION

A. Multifunction Digital Metering: UL listed or recognized microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Inputs: From sensors or current transformers from 100/5 through 5000/5 ratings and potential transformers up to 600 V.
2. Display: Switch selectable digital display of the following values with maximum accuracy tolerances as indicated:
   a. Phase currents, each phase.
   b. Phase-to-phase voltages, 3 phase.
   c. Phase-to-neutral voltages, 3 phase.
   d. Watts.
   e. VA.
   f. Vars.
   g. Power factor.
   h. Frequency.
   i. Megawatt demand with demand interval programmable from 5 to 60 minutes.
   j. Accumulated energy, megawatt hours.
   k. Accumulated values unaffected by power outages up to 72 hours.
   l. Alarm functions, including voltage and current loss, etc.

3. Mounting: Display and control unit flush or semi flush mounted in instrument compartment door.

B. Multifunction Digital Meter shall be Cutler-Hammer IQ 4130, or one of the following products of equal characteristics:

1. Square D Power Logic
2. General Electric Power Leader
3. Siemens Power Meter

2.6 RATINGS
A. System voltage, continuous main bus amperage and short-circuit-current ratings shall be as indicated on the drawings.

2.7 NAMEPLATE
A. Provide black plastic nameplate with 3/16" white letters showing panelboard designation, voltage and ampere ratings, short circuit ratings and manufacturer’s name and sales order number.

PART 3 - EXECUTION

3.1 INSTALLATION
A. General: Install panelboards and accessory items in accordance with manufacturers’ written installation instructions and applicable codes and standards.
B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels and brackets and temporary blocking of moving parts from panelboard units and components.
C. Provide the necessary support system to satisfy the requirements of the seismic region indicated on the drawings.

3.2 GROUNDING
A. Connections: As indicated. Tighten connections to comply with tightening torques specified in UL 486A and 486B.
B. Ground equipment to main electrical ground bus indicated. Provide minimum 5-ohm ground resistance at panelboard location.

3.3 CONNECTIONS
A. Tighten panelboard bus joint bolts and electrical connector and terminal bolts in accordance with manufacturer’s published torque-tightening values. Where manufacturer’s torque values are not stated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL
A. Upon completing installation of the system, perform the following tests:
   1. Make insulation resistance tests of panelboard buses, components and connection supply, feeder and control circuits.
   2. Make continuity tests of circuits.
B. Visual and Mechanical Inspections: Include the following inspections and related work:
   1. Inspect for defects and physical damage, testing laboratory, labels and nameplate compliance with up-to-date circuit connections.
   2. Verify that potential transformers, including their overcurrent protection and current transformers meet specified requirements.
   3. Perform operational test and exercise of mechanical components and other operable devices in accordance with manufacturer’s instruction manual.
4. Check panelboard anchorage, area clearances and alignment and fit of components.
5. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer’s instructions for proper torque values.

C. The contractor shall perform field adjustments of the protective devices as required to place the equipment in final operating condition. The settings shall be in accordance with the approved short-circuit study, protective device evaluation study and protective device coordination study. Field settings of devices adjustments and minor modifications to equipment to accomplish conformance with an approved short circuit and protective device coordination study shall be carried out by the Contractor at no additional cost to the owner.

3.5 CLEANING

A. Upon completion of installation, clean interior and exterior of panelboards. Remove paint splatters and other spots, dirt and debris. Touch up scratches and mars of finish to match original finish.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat in accordance with manufacturer’s recommendation within each section of panelboards throughout periods during which the panelboard is not in a space that is continuously under normal control of temperature and humidity.

END OF SECTION 260432
SECTION 26 04 55 – GROUNDING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.

1.2 SUMMARY
A. This Section includes grounding of electrical systems and equipment and basic requirements for grounding for protection of life, equipment, circuits and systems. Grounding requirements specified in this section may be supplemented in other sections of these specifications.

1.3 SUBMITTALS
A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
B. Product Data for grounding rods, connectors and connection materials, and grounding fittings.
C. Field tests and observation reports indicating and interpreting the test reports for compliance with performance requirements.

1.4 QUALITY ASSURANCE
A. Comply with NFPA 70.
B. Comply with UL 467.
C. Listing and Labeling: Provide products specified in this section that are UL listed and labeled.
D. Comply with NECA 331, “Standard for Building and Service Entrance Grounding and Bonding.”

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Chance: A. B. Chance Co
   2. Erico, Inc.; Electrical Products Group
   3. Ideal Industries, Inc
   4. ILSCO
   5. O-Z/Gedney Co
   6. Raco, Inc
   7. Thomas & Betts

2.2 GROUNDING AND BONDING PRODUCTS
A. Governing Requirements: Where types, sizes, ratings and quantities indicated are in excess of National Electrical Code requirements, the more stringent requirements and the greater size, rating and quantity indications govern.
B. Grounding Bus: Rectangular bar of annealed copper with tapped holes and insulated spacers.

2.3 WIRE AND CABLE GROUNDING CONDUCTORS

A. Comply with Division 26 Section 260120, “Conductors”. Conform to NEC Article 250, except as otherwise indicated, for conductor properties, including stranding.

B. Material: Use only copper wire for both insulated and bare grounding conductors and similar materials.

C. Equipment Grounding Conductors: Insulated with green color insulation, Type THW, THHN or THWN insulation.

D. Grounding-Electrode Conductors: Stranded cable.

E. Underground Conductors: Bare, tinned, stranded, except as otherwise indicated.

F. Bare Copper Conductors: Conform to the following:

2.4 MISCELLANEOUS CONDUCTORS

A. Grounding Bus: Bare, annealed-copper bars of rectangular cross section.

2.5 CONNECTOR PRODUCTS

A. Pressure Connectors: High conductivity plated units.

B. Bolted Clamps: Heavy duty type or Hammer Lock. Acorn clamps are not acceptable.

C. Exothermic-Welded Connections: Cadweld type, provided in kit form and selected per manufacturer’s instructions.

2.6 GROUND RODS

A. Copper-Plated Steel: 3/4" diameter, 10'-0" long.

PART 3 - EXECUTION

3.1 GENERAL

A. The entire electrical system and all electrical equipment shall be grounded in strict accordance with the National Electrical Code and as shown on the drawings.

B. The grounding system shall be continuous throughout the electrical system. Route along shortest and straightest paths possible. Avoid obstructing access or installing where they may be subjected to strain, impact or damage.
C. Neutral conductors shall be continuous throughout the electrical system and shall be grounded only at the service neutral at the service switch, or at the center point of a transformer secondary winding for a separately derived system as indicated on the drawings.

D. When the service entrance switch or switchboard has a neutral bus bar, this bus bar shall be bonded to the ground bus bar in the service entrance or switchboard.

E. When a steel conduit contains only ground wires, the ground wires shall be bonded to the conduit at both ends of the conduit run.

F. Service and equipment grounds to the water system piping shall be made using an approved clamp installed in an accessible location. Provide jumpers around water meters and insulated pipe connections.

G. Cabinets, panels, boxes, appliance frames, conduits and other non-current carrying metallic objects shall be grounded as required by the National Electrical Code.

H. Refer to Section 260010 - BASIC ELECTRICAL MATERIALS AND METHODS for Grounding Continuity tests required.

I. Underground ground rod, UFER concrete encased grounding electrode, and building steel connections shall be made with exothermic welds.

3.2 APPLICATION

A. Equipment Grounding Conductors: Comply with NEC Article 250 for types, sizes and quantities of equipment grounding conductors, except where specific types, larger sizes or more conductors than required by NEC are indicated.

1. Install equipment grounding conductor with circuit conductors for the items below in addition to those required by Code:
   a. Feeders and branch circuits.
   b. Receptacle circuits.
   c. Single-phase motor or appliance branch circuits.
   d. Three-phase motor or appliance branch circuits.
   e. Flexible raceway runs.
   f. Armored and metal-clad cable runs.

3.3 SEPARATELY DERIVED SYSTEMS

A. The secondary windings of transformers constitute a separately derived system. A bonding jumper shall be used to connect the equipment grounding conductors of the separately derived system, ahead of any system disconnecting means or overcurrent device.

B. A grounding electrode conductor shall be used to connect the grounded conductor of the separately derived system to the grounding electrode. This connection shall be made at the source of the separately derived system and ahead of any system disconnecting means or overcurrent device.

3.4 EMERGENCY GENERATOR GROUNDING
A. The emergency power generation system is NOT a separately derived system by virtue of the 3-pole transfer switches which do not switch the neutral (grounding conductor). Do not install a separate system ground electrode for the emergency generator.

B. Connect the emergency generator to the equipment ground system as required by the National Electrical Code.

C. Remove the neutral bonding jumper and do not ground the neutral at the generator, nor at any point between the generator and the service.

3.5 GROUNDING OF SPECIAL SYSTEMS

A. Furnish and install a green size 6 AWG copper wire in 1/2" conduit from the data terminal board and incoming telephone service to the main switchboard ground bus. The point of connection shall be located so that it is normally visible for inspection. Provide a Telecommunications Main Grounding Busbar (TMGB) equivalent to Erico TMGB - A14L15PT at terminal boards; mount TMGB at 24" AFF and terminate #6 AWG ground conductor to it.

B. Provide a green #6 AWG copper wire in ½" conduit from the Fire Alarm Control Panel to the main switchboard ground bus.

C. Provide an equipment ground bus adjacent to the service panelboard and provide binding conductors from this bus to service ground, FACP, IDF, Security System, Access Control System, CATV, Satellite, and all other special systems.

3.6 SYSTEM GROUNDING ELECTRODE

A. The grounding electrode shall be as near as practicable to, and preferably in the same area as, the grounding conductor connection to the system.

B. A metal underground water pipe, the metal frame of the building, a concrete-encased electrode and a ground ring electrode (where present) shall be bonded together to form the grounding electrode system.

C. Where none of the above electrodes is available, the grounding electrode shall be a “Made Electrode” as per Section 250.52 of the National Electrical Code.

D. Where a metal underground water pipe is the only grounding electrode available, it shall be supplemented by one of the grounding electrodes specified in Section 250.52 of the National Electrical Code.

E. A single electrode which does not have a resistance to ground of 15 ohms or less shall be augmented by one additional electrode of any of the types specified in Section 250.52 of the National Electrical Code.

3.7 EQUIPMENT GROUNDING

A. Provide an equipment bonding jumper from the grounding terminals of switches and receptacles to the grounded box that they are mounted in, unless the device is listed for self-grounding.
B. At motors, connect the ground conductor to the conduit with an approved grounding bushing, and to the metal frame with a bolted solderless lug. Bolts, screws and washers shall be bronze or cadmium plated steel.

C. Provide a flexible bonding strap, No. 6 AWG equivalent, across each flexible duct connection at each air handler, exhaust fan, supply fan, etc., and install to preclude vibration.

D. Exposed non-current-carrying metal parts of transformer installations shall be connected to the equipment grounding system.

E. Provide a flexible bonding strap, #6 AWG or equivalent, to each water heater and other piece of plumbing equipment that may become energized.

END OF SECTION 260455
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SECTION 26 04 70 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.

1.2 SUMMARY

A. This section covers circuit breaker lighting and appliance panelboards, power circuit breaker panelboards and fusible panelboards.

1.3 QUALITY ASSURANCE

A. Panelboards shall comply with the requirements of the National Electrical Code, NEMA, ANSI, IEEE and OSHA. Panelboards shall bear the Underwriter’s Laboratories Label.

B. Comply with NEMA Standard PB1, “Panelboards”.

C. Comply with UL Standards 67, “Panelboards” and UL50, “Cabinets and Boxes”.

D. Comply with NECA 407, “Recommended Practice for Installing and Maintaining Panelboards.”

1.4 SUBMITTALS

A. Product Data: For each panelboard and overcurrent protective device, including dimensions, ratings, finishes and components.

B. Panelboard Schedule: Typewritten for installation in panels.

C. Time-current curves for each overcurrent protective device.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Provide panelboard products of one of the following:

   1. Square D Co, Schneider Electric
   2. Eaton

2.2 CIRCUIT BREAKER LIGHTING AND APPLIANCE PANELBOARDS

A. Panelboards shall be dead front safety type equipped with circuit breakers. Each panelboard shall have an integrated short circuit withstand rating equal to the short circuit interrupting capacity of the circuit breakers. Panelboard bus structure and main lugs or main circuit breaker shall have current and voltage ratings and number of phases, poles, and wires as indicated on the drawings.
B. Circuit breakers shall be quick-make, quick-break, bolt-on type having over-center toggle mechanisms with thermal-magnetic trips and shall be trip free. Multi-pole circuit breakers shall have common trips and a single operating handle. Handle tie bars will not be accepted. Circuit breakers shall be provided with a means for indicating a tripped position, and shall be capable of being locked in the open position. Branch circuit breakers shall be replaceable without disturbing adjacent units. Circuit breaker voltage, ampere rating, interrupting rating and number of poles shall be as indicated on the drawings. Circuit breakers shall have a minimum short-circuit interrupting capacity of 10,000 amperes RMS for 120/208V panels and 14,000 amperes RMS for 277/480V panels. Circuit breakers shall be equipped with individually insulated, braced, and protected connectors.

1. Circuit breakers for equipment marked HACR Type shall be HACR type.
2. Circuit breakers with shunt trip feature shall be 120V A.C. trip voltage.
3. Circuit breakers with arc fault protection shall be AFCI type.
4. Circuit breakers with ground fault protection shall be GFCI type (5mA).
5. Circuit breakers with equipment ground fault protection shall be EPD type (30mA).

C. UL class A (5 milliampere sensitivity) and Class B (30 milliampere sensitivity) ground fault circuit protection shall be provided on 120 VAC branch circuits as shown on the plans or in the panelboard details. This protection shall be an integral part of the branch circuit breaker which also provides overload and short circuit protection for branch circuit wiring. Tripping of a branch circuit breaker containing ground fault circuit interruption shall not disturb the feeder circuit to the panelboard. A single pole circuit breaker with integral ground fault circuit interruption shall require no more panelboard branch circuit space than a conventional single pole circuit breaker.

D. The panel box shall be fabricated from code gauge galvanized steel. Unless otherwise indicated, panelboards shall be standard width with boxes having a minimum width of 20 inches and a maximum depth of 5-3/4 inches.

E. The panelboard front shall be surface or flush mounted as indicated on the drawings, fabricated from cold-rolled steel, coated with rust-inhibiting primer, finished with ANSI-61 light gray baked-on enamel paint, and shall have a door equipped with concealed hinges, a semi-flush or flush lock requiring a milled key, a framed directory card with a clear plastic covering mounted on the inside of the door. At least two keys shall be provided with each panelboard and all panelboard locks shall be keyed alike. The panelboard front shall be fastened to the panel box with machine screws or other approved fastening hardware and shall not be removable with the door in the closed position.

F. Interiors shall be equipped with bussing, circuit breakers, and adjustable means for positioning the interior within the enclosure.

G. Main bus and circuit breaker branch bus shall be copper having 98% conductivity. Aluminum bus shall not be acceptable. Full size neutral busses shall be insulated from the panelboard. The location of the main terminations shall be determined by the entrance of the feeders to the panelboard enclosure. In those cases where the feeders pass through the panelboard assembly, extra wide gutters shall be provided.
H. Double width panels: Where required or otherwise indicated, provide two panelboards under single front, each section with separate door and each section with similar space configuration, unless specified to be single width panel.

I. The panelboard interior shall be provided with a ground bus, which shall be bonded to the panelboard enclosure. Provide separate isolated ground bus where indicated, or where required.

J. The neutral bus and the ground bus shall be provided with an individual terminal or lug for each wire connected to it.

K. Terminals for feeder conductors to the panelboard mains and neutral shall be UL listed as suitable for the type of conductor specified. Terminal for branch circuit wiring, both breaker and neutral shall be UL listed as suitable for the type of conductor specified.

L. Bussing sequence shall be distributed phase sequence type. Bus sequence shall start at the top left phase bus of the interior for both top and bottom feed panels. Provisions or spaces for future breakers shall be located at the bottom of the panel and be fully bussed complete with all necessary mounting hardware less the breaker. Locate next to each breaker, space, or provision an individual number permanently affixed to the panelboard. Numbering tape or painted numbers shall not be acceptable.

M. The inside of the panel or door shall have a printed nameplate indicating the name of the panel manufacturer, shop order number, panel type, system voltage and bus ampacity. Panel shall be marked with its UL short circuit withstand ratings.

N. Circuit breaker lighting panelboards shall be Square D type NQ or NQOD, 120/208 volts, and Square D type NF, 277/480 volts or equal by General Electric, Eaton or Siemens.

O. The circuit breakers supplied shall be tested and listed as fully rated. This short circuit current rating shall be marked on the panelboards and shall be equal to or greater than the short circuit current available, in compliance with NEC Sections 110-22 and 240-86.

P. Load centers are not permitted unless specifically called out in the specification and on the drawings.

2.3 POWER CIRCUIT BREAKER PANELBOARDS

A. Power circuit breaker panelboards shall be dead-front safety type. The panel, including all bus bracing, circuit breakers, and associated current carrying components, shall have a minimum integrated short circuit withstand rating of 42,000 amperes RMS symmetrical. The panel bus structure and main lugs or main switch shall have current and voltage ratings, and number of phases, poles, and wires as indicated on the drawings.

B. Bus bars shall be copper. Neutral busses shall be insulated from the panel. Main horizontal bussing shall be full size throughout without reduction. The bus structure shall accommodate bolted branch switches as indicated on the drawings without modification to the bus assembly. No additional lineside wiring shall be necessary to add breakers. Space for future circuit breakers shall be bussed for the maximum devices that can be fitted into them.
C. Circuit breaker power panelboard shall be Square D type I-Line or equivalent from Eaton, GE or Siemens.

PART 3 - EXECUTION

3.1 General: Install panelboards and accessory items in accordance with NEMA PB 1.1, “General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less” and manufacturers’ written installation instructions.


3.3 Mounting: Plumb and rigid without distortion of box. Mount flush panels uniformly flush with wall finish. Top of trim shall be 74” AFF, unless noted otherwise. Mount adjacent boxes with tops aligned.

3.4 Circuit Directory: Provide typed directory reflective of final circuit changes required to balance panel loads.

3.5 Install filler plates in unused spaces.

3.6 Provision for Future Circuits at Flush Panelboards: Stub four 1-inch empty conduits from panel into accessible ceiling space or space designated to be ceiling space in future.

3.7 Auxiliary Gutter: Install where a panel is tapped to a riser at an intermediate location.

3.8 Wiring in Panel Gutters: Train conductors neatly in groups, bundle and wrap with wire ties after completion of load balancing.

3.9 Install panelboards with proper code required clearances at front of and above equipment. Coordinate with other trades prior to rough-in. Verify proper wall thickness for recessed panels.

3.10 Each panelboard shall have a black plastic nameplate with 1/4” white letters, indicating the panel number as shown on the drawings and source of supply per NEC 408-4 (B).

3.11 Install floor mounted panels on a 4” nominal height concrete housekeeping pad 1” larger in both dimensions than the equipment to be set. Provide steel reinforcing per ACI recommendations.

3.12 Provide seismic restraints for panels per section 260025, “Seismic Restraints” or as indicated on the plans.

END OF SECTION 260470
SECTION 26 04 75 – SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.

1.2 SUMMARY

A. This section includes surge protective devices for low-voltage power (< 1000 volts) equipment.

B. Related sections include the following:

1. Section 260140 - Wiring Devices, for devices with integral surge protection.
2. Section 260470 - Panelboards, for locations that require installation at the panel or sub-panel level.

C. The installation shall be in conformance with NEC Article 285.

1.3 SUBMITTALS

A. Product data: For each type of product indicated. Include rated capacities, shipping, installed and operating weights, furnished specialties, and options. Include model number, type, system voltage, phases, modes of protection, voltage protection rating (VPR) and nominal discharge current (In).

B. Product Certifications: Signed by manufacturers of surge protective devices, certifying that products furnished comply with the following testing and labeling requirements:

1. UL 1449 3rd Edition and UL 1283 listing and classifications. SPD shall bear the UL mark and shall be listed to UL 1449 3rd Edition and most recent edition of UL 1283. “Manufactured in accordance with” is not equivalent to UL listing and does not meet the intent of this specification.

C. Maintenance Data: for surge protective devices to include in maintenance manuals specified in Division 1.

D. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

A. Product must be made by a company engaged in the manufacture of such devices for a minimum of five years.

B. Source limitations: Obtain protective devices and accessories through one source from a single manufacturer.

C. Product options: Drawings indicate size, dimensional requirements, and electrical performance of suppressors and are based on the specific system indicated. Other manufacturers’ products complying with requirements may be considered by the engineer/architect greater than 14
days prior to bid. Samples may be required for approval. Devices mounted integral to the switchboard or panelboard do not meet the intent of this specification.

D. Electrical Components, devices and accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.


F. UL Compliance: Comply with UL 1449 Rev. 3 “UL Standard for Safety for Surge Protective Devices” and UL1283 “Electromagnetic Filters”.

1.5 PROJECT CONDITIONS

A. Placing into service: Do not energize or connect service entrance equipment or panelboards to their sources until the surge protective devices are installed and connected. Do not single phase, hi-pot or megger service entrance equipment without disconnecting the surge protective device, as damage to the surge protective device may result from these procedures.

B. Service conditions: Rate surge protective devices for continuous operation under the following conditions, unless otherwise indicated:

1. Maximum continuous operating voltage: Not less than 110% of nominal system operating voltage.
2. Operating Temperature: 30 to 120 deg. F
3. Humidity: 0 to 95%, non-condensing.
4. Altitude: Less than 12,000 feet above sea level.

1.6 COORDINATION

A. Coordinate location of field mounted surge suppressors to allow adequate clearances for maintenance.

1.7 WARRANTY

A. General warranty: Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Specialty warranty: Written warranty, executed by manufacturer agreeing to repair or replace components of surge suppressors that fail in materials or workmanship within eight years (96 months) from date of Substantial Completion or 10 years (120 months) from date of manufacture. Warranty shall include parts and labor.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

19-2726.01 & 19-2727.01
A. Manufacturers: Subject to compliance with requirements of this specification listed herein, provide products by one of the following manufacturers:

1. Current Technology
2. Emerson Network Power / Edco
3. Advanced Protection Technologies
4. Eaton Corporation
5. Schneider Electric
6. Siemens
7. Surge Suppression Incorporated

B. This specification is performance based, and any other vendors who desire approval to bid this project shall provide written documentation of any deviations from this specification, which shall be included in product submittal 14 days prior to bid.

2.2 SERVICE ENTRANCE SUPPRESSORS (TYPE 1)

A. Surge protective device: The system shall be constructed using multiple surge current diversion thermally protected metal oxide varistors (TPMOVs). The surge current circuit shall be designed and constructed in a manner that ensures surge current sharing. Use of gas tubes, silicon avalanche diodes or selenium cells are unacceptable unless documentation from a nationally recognized laboratory demonstrates current sharing of all dissimilar components at all surge current levels.

B. Product certifications: Products furnished comply with the following testing and labeling requirements: UL 1449 and UL 1283 listing and classifications including fault current rating to meet or exceed service entrance equipment.

C. Maximum continuous operating voltage: 115% (or 125% at 120VAC) of nominal system operating voltage at 60 hz.

D. Peak single impulse surge current capacity, in all modes. Data obtained from actual tests (per mode):

1. Line to Neutral: 150,000 Amperes
2. Line to Ground: 150,000 Amperes
3. Neutral to Ground: 150,000 Amperes
4. Line to Line: 150,000 Amperes

5. 120/240V units may be 40kA per Mode/80kA per phase

E. Listed to UL 1449 3rd Edition, Voltage Protection Ratings (VPR) shall not exceed:

1. 277/480 volt wye - L-N 1200, L-G 1200, N-G 1200, L-L 1800
2. 120/208 volt wye - L-N 800, L-G 800, N-G 800, L-L 1200
3. 120/240 volt - L-N 600, L-G 700, N-G 800, L-L 1000

F. Nominal Discharge Current Rating (In): 20 kA. (10kA for 120/240V services is acceptable)

G. Integral EMI/RFI filter for high frequency noise (10 kHz to 100 mHz) attenuation.
H. Features to include:

1. LED indicator lights for power and protective status for each mode.
2. Fault current UL tested and labeled for 100 kAIC.
3. NEMA type 4, 4X, or 12 enclosure.
4. Monitoring with audible alarm, including test and silence switch and form “C” alarm relay.
5. SPD will have a warranty period as stated above with five (5) years of free replacement.

2.3 PANELBOARD SUPPRESSORS (TYPE 1 OR 2)

A. Provide Type 1 suppressors at service entrance locations.

B. Surge protective device: The system shall be constructed using multiple surge current diversion thermally protected metal oxide varistors (TPMOVs). The surge current circuit shall be designed and constructed in a manner that ensures surge current sharing. Use of gas tubes, silicon avalanche diodes or selenium cells are unacceptable unless documentation from a nationally recognized laboratory demonstrates current sharing of all dissimilar components at all surge current levels.

C. Product certifications: Products furnished comply with the following testing and labeling requirements: UL 1449 3rd Edition and UL 1283 listing and classifications including fault current rating to meet or exceed panelboard.

D. Maximum continuous operating voltage: Between 115% (or 125% at 120VAC) of nominal system operating voltage at 60 HZ.

E. Peak single impulse surge current capacity all modes. Data obtained from actual tests (per mode):

   1. Line to Neutral: 100,000 Amperes
   2. Line to Ground: 100,000 Amperes
   3. Neutral to Ground: 100,000 Amperes
   4. Line to Line: 100,000 Amperes
   5. 120/240V units may be 40kA per Mode/80kA per phase

F. Listed to UL 1449 3rd Edition, Voltage Protection Ratings (VPR) as follows:

   1. 277/480 volt wye - L-N 1,200, L-G 1,200, N-G 1,200, L-L 1800
   2. 120/208 volt wye - L-N 800, L-G 800, N-G 800, L-L 1200
   3. 120/240 volt - L-N 600, L-G 700, N-G 800, L-L 1000

G. Nominal Discharge Current Rating (In): 20 kA.

H. Integral EMI/RFI filter for high frequency noise (10 kHz to 100 mHz) attenuation.

I. Features to include:

   1. LED indicator lights for power and protective status for each mode.
   2. Fault current UL tested and labeled for 100 kAIC.
3. NEMA type 3R, 4, 4X, or 12 enclosure.
4. SPD will have a warranty period as stated above with five (5) years of free replacement.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURGE PROTECTIVE DEVICES

A. Install devices at service entrance on load side, with ground lead bonded to service entrance ground.

B. Provide multi-pole, 60-amp (or as recommended by manufacturer) overcurrent protective device as a dedicated disconnect for the SPD at service entrance location, unless otherwise indicated on drawings.

C. Install devices for service entrance and panelboards, as indicated per electrical drawings, with conductors between suppressor and points of attachment as short and as straight as possible. Do not exceed manufacturer’s recommended lead length. Max length is 36 inches or less; If longer lengths are needed, provide premium low impedance cable equal to Current Technology High Performance Interconnect (HPI) or Emerson Network Power AccuGuide (ACG).

D. Provide multi-pole, 30 amp (or as recommended by manufacturer) overcurrent protective device as a dedicated disconnect for the SPD at panelboard locations, unless otherwise indicated on drawings.

E. Mount suppressor as close as possible to switchgear and panelboard point of connection. Do not mount internal to switchgear or panelboards to facilitate ease of future maintenance and/or replacement. Installer may reasonably rearrange OCPD location from that shown on drawing to ensure the shortest and straightest possible leads to SPD’s.

3.2 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 and UL 486B.

3.3 FIELD QUALITY CONTROL

A. Testing: Engage a qualified testing agency to perform the following field quality control testing:

1. After installing the surge protective devices, but before electrical circuitry has been energized, test for compliance with requirements. Verify service and separately derived system neutral-to-ground bonding jumpers per NEC.
2. Complete start-up checks and voltage verifications according to manufacturer’s written instructions.
3. Perform visual and mechanical inspection on each unit. Certify that units are installed per manufacturer’s recommendations.

B. Repair or replace malfunctioning units. Retest after repairs or replacements are made.

3.4 DEMONSTRATION
A. Engage a manufacturer’s representative to demonstrate proper operation of the system and to train owner’s maintenance personnel in proper evaluation of suppressor condition and procedure to repair or replace defective devices.

1. Review operation and maintenance manuals.
2. Review performance specifications of devices supplied to show they comply with specifications herein.
3. Schedule training with Owner, through Architect or General Contractor, with at least seven days advance notice.
4. Contractor shall provide letter to owner that states units are installed per manufacturer’s recommended installation procedures and system is functioning properly and warranty is initiated.

END OF SECTION 260475
SECTION 26 05 00 – INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.

B. Section 260000 - Electrical General Conditions

C. Section 260010 - Basic Electrical Materials and Methods

D. Section 260025 - Seismic Restraints

1.2 SUMMARY

A. Furnish and install new lighting fixtures as shown on the drawings and as specified herein.

1.3 QUALITY ASSURANCE

A. Fixtures and components shall be U.L. listed and meet applicable national and local code requirements for the particular application. Fixtures shall bear the UL label.

B. Comply with applicable ANSI, UL and NEMA standards including, but not limited to, the following:

1. Lamps: ANSI C82.11 and C82.4.
3. NEMA LL-9-09, “Dimming of T8 Fluorescent Lighting Fixtures.
4. NEMA SSL-1-10, “Electronic Drivers for LED Devices, Arrays, or Systems.

1.4 SUBMITTALS

A. Product Data: For each type of light fixture including dimensions, features, accessories, ballasts, lamps, weights and supports.

PART 2 - PRODUCTS

2.1 GENERAL

A. Lighting equipment is shown in the fixture schedule on the drawings to establish general requirements. The fixture manufacturers' catalog numbers are not to be construed as all inclusive. Equivalent products manufactured by Columbia, Cooper, Daybrite, Hubbell, Kurt Versen, Lithonia, Lightolier, Prescolite or Williams are considered equivalent. Furnish and install accessories or hardware required for a complete installation. Light fixtures shall be equipped with proper accessories, lenses, louvers, reflectors, shields, hangers, clips, frames, lamps, ballasts, and other components essential for proper installation in or on walls, ceilings or other construction features, and shall be properly painted for protection and preservation appropriate to the place installed.
B. Refer to the Room Finish Schedule on the Architectural drawings to verify the type of ceiling construction. Fixtures specified in the Fixture Schedule are based on the ceiling construction contemplated at the time of design. Final ceiling construction may be different than the type specified. EC shall confirm the ceiling construction with the General Contractor and Owner’s Representative prior to construction. Provide fixtures with the proper hardware for installation in or on the specified ceiling.

C. All fixtures shall bear a U.L. Listing.

2.2 FIXTURES AND Fixture COMPONENTS

A. Metal Parts: Free from burrs, sharp corners and edges along with any metal parts shall be painted after fabrication.

B. Sheet Metal Components: Steel, except as indicated. Formed and reinforced to prevent warping and sagging.

C. Doors, Frames and Other Internal Access: Smooth operating, free from light leakage under operating conditions and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers and other pieces to prevent accidental falling during relamping and when secured in operating position. Door frames shall have captive spring latches.

D. Reflecting Surfaces: Minimum reflectance as follows, except as otherwise indicated:
   1. White Surfaces: 70 percent
   2. Specular Surfaces: 80 percent
   3. Diffusing Specular Surfaces: 75 percent
   4. Laminated Silver Metalized Film: 90 percent

E. Lenses, Diffusers, Covers and Globes: 100 percent virgin acrylic plastic or water white, annealed crystal glass, except as otherwise indicated.
   1. Plastic: High resistance to yellowing and other changes due to aging, exposure to heat and UV radiation.
   2. Lens Thickness: 0.125 inch (3mm) nominal; except where greater thickness is indicated.

F. Finishes:
   1. Manufacturer’s standard, except as otherwise indicated, applied over corrosion-resistant treatment or primer, free of streaks, runs, holidays, stains, blisters and similar defects.
   2. Finish applied on metal surfaces after forming or fabrication.

2.3 LED LIGHT FIXTURES

A. General
   1. LED light fixtures shall be in accordance with IES, NFPA, UL, as shown on the drawings, and as specified.
   2. LED light fixtures shall be Reduction of Hazardous Substances (RoHS)-compliant and Design Lights Consortium Qualified Products.
3. LED drivers shall include the following features unless otherwise indicated:
   a. Minimum efficiency: 85% at full load.
   b. Minimum Operating Ambient Temperature: -20° C. (-4° F.)
   c. Input Voltage: 120 - 277V (±10%) at 60 Hz.
   d. Integral short circuit, open circuit, and overload protection.
   e. Power Factor: = 0.95.
   f. Total Harmonic Distortion: = 20%.

4. LED modules shall include the following features unless otherwise indicated:
   a. Comply with IES LM-79 and LM-80 requirements.
   b. Minimum CRI 80 and color temperature 3500K unless otherwise specified in LIGHTING FIXTURE SCHEDULE.
   c. Minimum Rated Life: 50,000 hours per IES L70.
   d. Light output lumens as indicated in the LIGHTING FIXTURE SCHEDULE.
   e. Minimum luminaire efficacy of 85 lumens per watt.

B. LED Downlights:
   1. Housing, LED driver, and LED module shall be products of the same manufacturer.

C. LED Troffers:
   1. LED drivers, modules, and reflector shall be accessible, serviceable, and replaceable from below the ceiling.
   2. Housing, LED driver, and LED module shall be products of the same manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures shall be installed in accordance with manufacturer's recommendations, instructions contained herein or on the drawings and field conditions.

B. Locations of fixtures, unless specifically dimensioned on the architectural or electrical plans, may be scaled from the plans and adjusted as required to meet job conditions.

C. Locations of light fixtures on the electrical plans are diagrammatic. Refer to Architectural Reflected Ceiling drawings for dimensional data, location and reference data including work or other trades. Coordinate installation of lighting fixtures with those drawings.

D. Provide necessary accessories required for the support or mounting of fixtures. Where necessary, provide bridging between structural members. No fixtures shall be supported directly from the ceiling tiles or from duct work, piping or work of other trades.

E. Recessed fixtures shall be mounted with flanges tight to the finished ceilings. Provide drywall flanges for fixtures installed in drywall ceilings.
F. Surface and suspended fixtures shall be securely mounted to the structural system, the ceiling superstructure, or to supporting members. Surface fixtures shall be mounted in proper alignment with the ceiling. Suspended fixtures shall be mounted from vertical supports. Swivel type hangers or sloped ceiling adapter cones shall be provided on sloping ceilings.

G. Recessed LED, fixtures shall be independently supported with a minimum of two metal channels spanning ceiling tees or ceiling support steel channels. No fixture shall be supported directly from the ceiling tile.

H. Support for Recessed and Semi-Recessed Grid-Type LED: Units may be supported from suspended ceiling support system with support wires at opposite corners of the fixture attached to building structure and four (4) grid clips.

1. Fixtures of Sizes Less than Ceiling Grid: Center in acoustical panel. Support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees. Do not support fixtures by ceiling acoustical panels.

I. Wall mounted fixtures shall be securely mounted with a minimum of two screws to the wall or to studs or framing within the wall to prevent the possibility of movement or misalignment.

J. Install remote mounted ballasts in a ventilated enclosure, which shall be secured to the building structure with vibration isolating mountings. Connections shall be thru flexible conduit. Ballasts shall be mounted in a manner which will promote heat transfer to the housing.

K. Adjustable fixtures shall be aimed as directed by the Architect and/or Engineer.

L. Install lamps in each fixture.

3.2 Prior to substantial completion, clean fixture lenses and reflectors and replace inoperative lamps. Replace or repair damaged or blemished fixtures.

3.3 SEISMIC SUPPORTS

A. Recessed mounted lighting fixtures shall have seismic supports to meet the criteria listed on structural plans and IBC.

B. Recessed LED installed in lay-in ceilings shall be provided with four (4) earthquake clips for securing to the restrained Tee bars. If ceiling grid is not seismically restrained, provide two (2) 12 gauge support cables on opposite corners of the fixture attached to building structure above.

C. Recessed LED, fixtures shall have support mounting rails screwed to the ceiling Tee bars.

3.4 FIELD TESTS

A. Test emergency lighting by interrupting power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

END OF SECTION 260500
SECTION 26 05 25 – EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.

1.2 SUMMARY

A. This Section includes exterior lighting fixtures, lamps, ballasts, drivers, pole standards and accessories.

1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Submit Product Data describing fixtures, lamps, ballasts, poles and accessories. Arrange Product Data for fixtures in order of fixture designation. Include data on fixtures, poles, accessories, finishes and the following:

1. Outline drawings indicating dimensions and principal features of fixtures and poles.
2. Electrical Ratings and Photometric Data: Certified results of independent laboratory tests for fixtures and lamps. Include photometric plans indicating footcandle levels on site plan at a 10’x10’ grid.
3. Wind Resistance Calculations: Certified by a registered professional engineer.
4. Shop Drawings detailing nonstandard fixtures and poles and indicating dimensions, weights, method of field assembly, components and accessories.
5. Anchor-Bolt Templates: Keyed to specific poles and certified by manufacturer.

1.4 QUALITY ASSURANCE

A. Electrical Component Standard: Provide components that comply with NFPA 70 and that are listed and labeled by UL.

B. Comply with ANSI C2.


1.5 STORAGE AND HANDLING OF POLES

A. General: Store poles on decay-resistant treated skids at least 12 inches (300 mm) above grade and vegetation. Support pole to prevent distortion and arrange to provide free air circulation.

B. Metal Poles: Retain factory-applied pole wrappings until just before pole installation.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage and are identified with labels describing contents.
1. Lamps: Four (4) percent of each type and rating installed. Furnish at least one of each type.
2. Glass and Plastic Lenses, Covers and Other Optical Parts: Four (4) percent of each type and rating installed. Furnish at least one of each type.
3. Ballasts: One (1) percent of each type and rating installed. Furnish at least one of each type.
4. Globes and Guards: Furnish at least one of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide the products specified in Lighting Fixture Schedule shown on drawings. Equivalent products manufactured by Gardco, Cooper, Hubbell, Kim, Lithonia and Widelite will be acceptable.

2.2 FIXTURES AND FIXTURE COMPONENTS, GENERAL

A. Metal Parts: Free from burrs, sharp edges and corners.
B. Sheet Metal Components: Corrosion-resistant aluminum, except as otherwise indicated. Form and support to prevent warping and sagging.
C. Housing: Rigidly formed, weather- and light-tight enclosures that will not warp sag or deform in use. Provide filter/breather for enclosed fixtures.
D. Doors, Frames and Other Internal Access: Smooth operating, free from light leakage under operating conditions and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers and other pieces to prevent accidental falling during relamping and when secured in operating position. Provide for door removal for cleaning or replacing lens. Arrange for door opening to disconnect ballast.
E. Exposed Hardware Material: Stainless steel.
F. Reflecting Surfaces: Minimum reflectance as follows, except as otherwise indicated:
   1. White Surfaces: 85 percent.
   2. Specular Surfaces: 83 percent.
   3. Diffusing Specular Surfaces: 75 percent.
G. Lenses and Refractors: Materials as indicated. Use heat- and aging-resistant, resilient gaskets to seal and cushion lens and refractor mounting in fixture doors.
H. Provide Bussmann HEB style fuse holder and fuse. Size and type as recommended by manufacturer.

2.3 FIXTURE SUPPORT COMPONENTS

A. Pole-Mounted Fixtures: Conform to AASHTO LTS-4.
B. Wind-load strength of total support assembly, including pole, arms, appurtenances, base and anchorage, is adequate to carry itself plus fixtures indicated at indicated heights above grade.
without failure, permanent deflection or whipping in steady winds of 100 mi./h (160 km/h) with a gust factor of 1.3.

C. Arm, Bracket and Tenon Mount Materials: Match poles’ finish.

D. Mountings, Fastenings and Appurtenances: Corrosion-resistant items compatible with support components. Use materials that will not cause galvanic action at contact points. Use mountings that correctly position luminaire to provide indicated light distribution.

E. Pole Bases: Anchor type with galvanized steel hold-down or anchor bolts, leveling nuts and bolt covers. Provide with bolt cover.

F. Poles: Steel tubing conforming to ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psi (317 MPa). Poles are one-piece construction up to 40 feet (12 m) in length and have access handhole in wall.

G. Metal Pole Grounding Provisions: Welded 1/2-inch (12-mm) threaded lug, accessible through handhole.

H. Metal Pole Brackets: Designed to match pole metal. Provide cantilever brackets without underbrace, in sizes and styles indicated, with straight tubular end section to accommodate fixtures.

I. Pole-Top Tenons: Fabricated to support fixture or fixtures and brackets indicated and securely fastened to pole top.

J. Concrete for Pole Foundations: Comply with Division 3 Section “Cast-in-Place Concrete.” Use 3000-psig (20.7-MPa) strength, 28-day concrete.

K. Provide additional device and tapped holes as required for wiring devices, cameras and other equipment as called for on the project plans. Coordinate locations with applicable trades.

2.4 FINISHES

A. Metal Parts: Manufacturer’s standard finish, except as otherwise indicated, applied over corrosion-resistant primer, free of streaks, runs, holidays, stains, blisters and similar defects.

B. Other Parts: Manufacturer’s standard finish, except as otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set units plumb, square, level and secure according to manufacturer’s written instructions and approved Shop Drawings.

B. Provide necessary accessories required for the support or mounting of fixtures. Where necessary, provide bridging between structural members.

C. Concrete Foundations: Construct according to Division 3 Section “Cast-in-Place Concrete.”
1. Comply with details and manufacturer’s recommendations for reinforcing, anchor bolts, nuts and washers. Verify anchor-bolt templates by comparing with actual pole bases furnished.

2. Finish: Trowel and rub smooth parts exposed to view.

D. Pole Installation: Use web fabric slings (not chain or cable) to unload, store, raise and set poles.

E. Fixture Attachment: Fasten to indicated structural supports.

F. Fixture Attachment with Adjustable Features or Aiming: Attach fixtures and supports to allow aiming for indicated light distribution.

G. Lamp fixtures with indicated lamps according to manufacturer’s written instructions. Replace malfunctioning lamps.

H. Install wiring, wiring devices, cameras and appurtenances as required or indicated on project plans.

3.2 GROUNDING

A. Ground fixtures and metal poles according to Division 26 Section 260455 “Grounding System.”

1. Poles: Install 10-foot (3-m) 3/4” diameter driven ground rod at each pole and connect ground rod to pole-mounted ground lug with #6 AWG solid bare conductor.

3.3 FIELD QUALITY CONTROL

A. Inspect each installed unit for damage. Replace damaged fixtures and components.

B. Tests and Observations: Verify normal operation of lighting units after installing fixtures and energizing circuits with normal power source. Include the following:

   1. Check for intensity of illumination.
   2. Check for uniformity of illumination.
   3. Check for excessively noisy drivers.
   4. Adjust lamps and reflectors as required.

C. Replace or repair damaged and malfunctioning units, make necessary adjustments and retest. Repeat procedure until all units operate properly.

3.4 ADJUSTING AND CLEANING

A. Clean units after installation. Use methods and materials recommended by manufacturer.

B. Adjust Aimable fixtures to provide required light intensities.

END OF SECTION 260525
SECTION 26 06 10 – EMERGENCY GENERATOR

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.

1.2 SCOPE
A. Provide, install, and acceptance test a complete and operable Emergency/Standby electric generating system, including all devices and equipment specified herein, as shown on the drawings, or required for the service. Equipment shall be new, factory tested, and delivered ready for installation.

1.3 QUALITY ASSURANCE
A. Comply with NECA / EGSA 404, “Standard for Installing Generator Sets.”
B. Comply with NFPA 110
C. Comply with UL 2200.
D. EPA Certified for Stationary Emergency Applications.

1.4 SUBMITTAL
A. Provide six sets of the following information for review:
   1. Manufacturer’s product literature and performance data, sufficient to verify compliance to specification requirements.
   2. A paragraph by paragraph specification compliance statement, describing the differences between the specified and the proposed equipment.
   3. Manufacturer’s certification of prototype testing.
      a. Manufacturer’s published warranty documents.
   4. Shop drawings showing plan and elevation views with certified overall dimensions, as well as wiring interconnection details.
   5. Interconnection wiring diagrams showing all external connections required; with field wiring terminals marked in a consistent point-to-point manner.
   6. Manufacturer’s installation instructions.

1.5 WARRANTY
A. Shall be provided for all products against defects in materials and workmanship for one year period from the start-up date.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Subject to compliance with requirements, provide equipment as manufactured by one of the following:

19-2726.01 & 19-2727.01
EMERGENCY GENERATOR 26 06 10 - 1
1. Cummins/Onan
2. Caterpillar
3. Kohler
4. Generac
5. Aksa

2.2 DIESEL ENGINE-GENERATOR SET

A. 4-cycle, 1800 rpm, diesel engine generator set. Generator set ratings: per drawing at 0.8 PF, standby rating, based on site conditions of 113 deg F ambient and 500 ft above sea level.

B. Prototype tests shall have been performed on a complete and functional unit; component level type tests will not substitute for this requirement. Prototype testing shall comply with the requirements of NFPA 110.

C. Performance

1. Voltage regulation shall be +/- 1.0 percent for any constant load between no load and rated load.
2. Frequency regulation shall be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.25%.
3. The diesel engine-generator set shall be capable of single step load pick up of 100% nameplate kW and power factor, less applicable derating factors, with the engine-generator set at operating temperature.
4. The generator set shall be capable of sustaining a minimum of 90% of rated no load voltage with the specified kVA load at near zero power factor applied to the generator set.
5. Generator set shall be EPA qualified to the current required tier rating.

2.3 ENGINE

A. The engine shall be diesel, 4 cycle, radiator and fan cooled. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories. Two cycle engines are not acceptable. Engine accessories and features shall include:

1. An electronic governor system shall provide automatic isochronous frequency regulation.
2. Skid-mounted radiator and cooling system rated for full load operation in 104 degrees F (40 degrees C) ambient as measured at the generator air inlet.
3. An electric starter(s) capable of three complete cranking cycles without overheating.
4. Positive displacement, mechanical, full pressure, lubrication oil pump.
5. Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.
7. Replaceable dry element air cleaner with restriction indicator. Flexible supply and return fuel lines.
8. Engine mounted battery charging alternator, 37 ampere minimum, and solid-state voltage regulator.

2.4 AC GENERATOR

A. The AC generator shall be; synchronous, four pole, 2/3 pitch, revolving field, drip-proof construction, single pre-lubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. All insulation system components shall meet NEMA MG1 temperature limits for Class H insulation system. Actual temperature rise measured by resistance method at full load shall not exceed 125 degrees C in a 40 degree C ambient. Alternator shall be provided with protection to prevent damage due to any external fault or overload condition.

B. The generator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage not more than 5 percent above or below rated voltage.

C. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of rated current for not more than 10 seconds.

2.5 ENGINE STATUS MONITORING

A. The following information shall be available from a digital status panel on the generator set control:

1. engine oil pressure (psi or kPA)
2. engine coolant temperature (degrees F or C)
3. engine oil temperature (degrees F or C)
4. engine speed (rpm)
5. number of hours of operation (hours)
6. number of start attempts
7. battery voltage (DC volts)

2.6 CONTROL FUNCTIONS

A. The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and # of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with 15 second rest period between cranking periods.

B. The control system shall include an idle mode control, which allows the engine to run in idle mode in the RUN position only. In this mode, the alternator excitation system shall be disabled.

C. The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting. The governor control shall be suitable for use in paralleling applications without component changes.
D. The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-600 seconds) functions.

E. The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature which is capable of discriminating between failed sender or wiring components, and an actual failure conditions.

2.7 ALTERNATOR CONTROL FUNCTIONS

A. The generator set shall include an automatic voltage regulation system which is matched and prototype tested with the governing system provided. It shall be immune from misoperation due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulation system shall be equipped with three-phase RMS sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of [58-59] HZ. The voltage regulator shall include adjustments for gain, damping, and frequency roll-off. Adjustments shall be broad range, and made via digital raise-lower switches, with alpha-numeric LED readout to indicate setting level.

B. The voltage regulation system shall include provisions for reactive load sharing and electronic voltage matching for paralleling applications. Motorized voltage adjust pot is not acceptable for voltage matching.

C. Controls shall be provided to monitor the output current of the generator set and initiate an alarm when load current exceeds 110% of the rated current of the generator set on any phase for more than 60 seconds. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator.

D. Controls shall be provided to monitor the KW load on the generator set, and initiate an alarm condition when total load on the generator set exceeds the generator set rating for in excess of 5 seconds.

E. Controls shall include a load shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.

F. An AC over/under voltage monitoring system which responds only to true RMS voltage conditions shall be provided. The system shall initiate shutdown of the generator set when alternator output voltage exceeds 110% of the operator-set voltage level for more than 10 seconds, or with no intentional delay when voltage exceeds 130%. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85% for more than 10 seconds.

G. A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is less than 10VDC or more than 16 VDC. During engine starting, the low voltage limit shall be disabled, and if DC voltage drops to less than 7 volts for more than two seconds a "weak battery" alarm shall be initiated.

2.8 ENGINE-GENERATOR SET CONTROL
A. The NEMA 1 enclosed control panel shall be mounted on the generator set with vibration isolators. The control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered. The generator set mounted control shall include the following features and functions:

1. Three position control switch labeled RUN/OFF/AUTO. In the RUN position the generator set shall automatically start, and accelerate to rated speed and voltage. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.

2. RESET switch. The RESET switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.

3. PANEL LAMP switch. Depressing the panel lamp switch shall cause the entire panel to be lighted with DC control power.

4. Generator Set AC Output Metering. The generator set shall be provided with a metering set with the following features and functions:

   a. Analog AC Voltmeter, dual range, 90 degree scale, 2% accuracy; Analog AC Ammeter, dual range, 90 degree scale, 2% accuracy; Analog Frequency/RPM meter, 45-65 Hz, 1350-1950 RPM, 90 degree scale, +/- 0.6 Hz accuracy.

   b. Seven position phase selector switch with OFF position to allow meter display of current and voltage in each generator phase. When supplied with reconnectable generators, the meter panel shall be reconnectable for the voltage specified.

B. Generator Set Alarm And Status Display

1. The generator set shall be provided with alarm and status indicating lamps to indicate non-automatic generator status, and any activated alarm or shutdown conditions. The lamp condition shall be clearly apparent under bright room lighting conditions. The generator set control shall indicate the existence of the following alarm and shutdown conditions on the display panel:

   a. switch off (flashing)
   b. low oil pressure (alarm)
   c. low oil pressure (shutdown)
   d. low coolant temperature (alarm)
   e. high coolant temperature (alarm)
   f. high coolant temperature (shutdown)
   g. low coolant level (shutdown)
   h. overcrank (shutdown)
   i. overspeed (shutdown)
   j. low fuel-daytank (alarm)
   k. ground fault (alarm)(optional--when required by code or specified)

2. In addition, provisions shall be made for indication of two customer-specified alarm or shutdown conditions. The non-automatic indicating lamp shall be red, and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.
C. Engine Status Monitoring

1. The following devices shall be provided on the generator set control:
   a. engine oil pressure gauge
   b. engine coolant temperature gauge
   c. engine operation hour gauge
   d. battery voltage (DC volts)

D. Control Functions

1. The control system provided shall include a cycle cranking system, which shall be for 3 cranking periods of 15 seconds each, with 15 second rest period between cranking periods. Fail to start shall be indicated by operation of the over crank alarm indication lamp.

E. Alternator Control Functions

1. The generator set shall include an automatic voltage regulation system which is matched and prototype tested with the governing system provided. It shall be immune from misoperation due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of 58 HZ for 60 Hz machines.

2. Voltage adjusting rheostat, locking screwdriver type, to adjust voltage +/- 5% from rated value.

3. When required by National Electrical Code or indicated on project drawings, the control system shall include a ground fault monitoring relay. The relay shall be adjustable from 100-1200 amps, and include adjustable time delay of 0-1.0 seconds. The relay shall be for indication only and not trip or shut down the generator set. Note bonding and grounding requirements for the generator set, and provide relay which will function correctly in system as installed.

F. Control Interfaces for Remote Monitoring

1. Provide the following features in the control system:
   a. Form "C" dry common alarm contact set rated 2A @ 30VDC to indicate existence of any alarm or shutdown condition on the generator set.
   b. One set of contacts rated 2A @ 30VDC to indicate generator set is ready to load. The contacts shall operate when voltage and frequency are greater than 90% of rated condition.

2.9 BASE

A. The engine-generator set shall be mounted on a heavy duty steel base to maintain alignment between components. The base shall incorporate a battery tray with hold-down clamps within the rails.
2.10 GENERATOR SET AUXILIARY EQUIPMENT AND ACCESSORIES

A. Water Jacket Heater

1. Engine mounted, thermostatically controlled, water jacket heater for each engine. The heater shall be sized as recommended by the generator set manufacturer. Heater voltage shall be as shown on the project drawings. Provide proper power supply circuits for the heater as required for the voltage and load of the heater, connected to a normally served distribution circuit.

B. Vibration Isolation

1. Vibration isolators, spring/pad type, quantity as recommended by the generator set manufacturer. Isolators shall include seismic restraints if required by site location.

C. Exhaust Silencer

1. Exhaust muffler shall be provided for each engine, size and type as recommended by the generator set manufacturer. The mufflers shall be residential grade. Exhaust system shall be installed according to the generator set manufacturers recommendations and applicable codes and standards.

D. Starting and Control Batteries

1. Starting battery bank, calcium/lead antimony type, 12 volt DC, sized as recommended by the generator set manufacturer, shall be supplied for each generator set with battery cables and connectors.

E. Generator Set Main Circuit Breaker

1. Generator main circuit breaker: set-mounted and wired, UL listed, molded case type with electronic trip unit, rated, 3-pole, 600volts and as indicated on the drawings. Submittals shall demonstrate that the circuit breaker provides proper protection for the alternator by a comparison of the trip characteristic of the breaker with the thermal damage characteristic of the alternator. Field circuit breakers shall not be acceptable for generator overcurrent protection.

F. Battery Charger

1. Provide battery charger, equalizer float-type, size and type as recommended by the generator set manufacturer. Provide 120 Volt circuit to battery charger and cables between battery charger and batteries.

G. Remote Annunciator:

1. Provide and install a 20-light LED remote alarm annunciator with horn, located as shown on the drawings or in a location which can be conveniently monitored by facility personnel. The remote annunciator shall provide all the audible and visual alarms called for by NFPA Standard 110 for level 1 systems; and in addition shall provide indications for high battery voltage, low battery voltage, loss of normal power to the charger. Spare lamps shall be provided to allow future addition of other alarm and status functions to
the annunciator. Provisions for labeling of the annunciator in a fashion consistent with the specified functions shall be provided. Alarm silence and lamp test switch(es) shall be provided. LED lamps shall be replaceable, and indicating lamp color shall be capable of changes needed for specific application requirements. Alarm horn shall be switchable for all annunciation points. Alarm horn (when switched on) shall sound for first fault, and all subsequent faults, regardless of whether first fault has been cleared, in compliance with NFPA110 3-5.6.2.

H. Provide a remote emergency power off switch and locate as indicated on plans.

2.11 OUTDOOR WEATHER-PROTECTIVE SOUND ATTENUATING HOUSING

A. Generator set housing shall be provided factory-assembled to generator set base and radiator cowling. Housing shall provide ample airflow for generator set operation at rated load in the ambient conditions previously specified. The housing shall have hinged side-access doors and rear control door. All doors shall be lockable. All sheet metal shall be primed for corrosion protection and finish painted with the manufacturer’s standard color using a two-step electro coating paint process, or equal meeting the performance requirements specified below. All surfaces of all metal parts shall be primed and painted. The painting process shall result in a coating which meets the following requirements:

1. Primer thickness, 0.5-2.0 mils. Top coat thickness, 0.8-1.2 mils.
   a. Gloss, per ASTM D523-89, 80% plus or minus 5%. Gloss retention after one year shall exceed 50%.
   b. Crosshatch adhesion, per ASTM D3359-93, 4B-5B.
   c. Impact resistance, per ASTM D2794-93, 120-160 inch-pounds.
   d. Salt Spray, per ASTM B117-90, 1000+ hours.
   e. Humidity, per ASTM D2247-92, 1000+ hours.
   f. Water Soak, per ASTM D2247-92, 1000+ hours.

B. Painting of hoses, clamps, wiring harnesses, and other non-metallic service parts shall not be acceptable. Fasteners used shall be corrosion resistant, and designed to minimize marring of the painted surface when removed for normal installation or service work.

2.12 FUEL STORAGE

A. Sub-base Fuel Storage Tank

1. Provide a dual wall sub-base fuel storage tank with sufficient capacity for 48 hours of run time at full rated load. The tank shall be constructed of corrosion resistant steel and shall be UL listed. The equipment, as installed, shall meet all local and regional requirements for above ground tanks.
2. Provide an overflow / rupture alarm in emergency tank basin to indicate fuel in basin and connect to remote annunciator panel.
3. The tank shall be filled with fuel prior to start up tests.

PART 3 - EXECUTION

3.1 EXECUTION
A. Installation

1. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.
2. Installation of equipment shall include furnishing and installing all interconnecting wiring between all equipment provided for the on-site power system.
3. Generator shall be installed on concrete housekeeping pad. Equipment shall be permanently fastened to the pad in accordance with manufacturer's instructions and seismic requirements of the site.
4. Equipment shall be initially started and operated by representatives of the manufacturer.
5. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to final testing of the system.

3.2 FACTORY TESTS

A. Generator set factory tests on the equipment shall be performed at rated load. Tests shall include: run at full load, maximum power, voltage regulation, transient and steady-state governing, single step load pickup, and function of safety shutdowns.

3.3 ON-SITE ACCEPTANCE TEST

A. The complete installation shall be tested for compliance with the specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer. The Engineer shall be notified in advance and shall have the option to witness the tests.

B. Installation acceptance tests to be conducted on-site shall include a "cold start" test, a two hour full load test, and a one-step rated load pickup test in accordance with NFPA 110. Provide a resistive load bank and make temporary connections for full load test, if necessary.

3.4 TRAINING

A. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than 4 hours in duration and the class size shall be limited to 5 persons. Training date shall be coordinated with the facility owner.

END OF SECTION 260610
SECTION 26 06 20 – TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.

1.2 SUMMARY

A. This Section includes automatic transfer switches rated 600 V.

1.3 SUBMITTALS

A. General: Submit the following according to Conditions of Contract and Division 1 Specification Sections:

1. Shop drawings or published product data for each transfer switch, including dimensioned plans, sections and elevations showing minimum clearances, conductor entry provisions; gutter space; installed features and devices and materials lists.
2. Wiring diagrams, elementary or schematic, differentiating between manufacturer-installed and field-installed wiring.
3. Single-line diagrams of transfer switch units showing connections between automatic transfer switch, by-pass/isolation switch, power source and load, plus interlocking provisions.
4. Operation and maintenance data for each type of product, for inclusion in Operating and Maintenance Manual specified in Division 1.
5. Manufacturer’s certificate of compliance to the referenced standards and tested short-circuit closing and withstand ratings applicable to the protective devices and current ratings used in this Project, as indicated and as specified in paragraph “Tested Fault Current Ratings.”

1.4 QUALITY ASSURANCE

A. Manufacturer’s Qualifications: Firms experienced in manufacturing equipment of the types and capacities indicated and have a record of successful in-service performance.

B. Emergency Service: Manufacturer shall maintain a service center capable of providing emergency maintenance and repairs at project site with an 8-hour maximum response time.


G. UL Listing and Labeling: Items furnished under this section shall be listed and labeled by UL for emergency service under UL Standard 1008.

H. Single-Source Responsibility: Obtain ATSs, BP/Iss, remote annunciators and remote annunciator and control panels from a single manufacturer that assumes responsibility for all system components furnished.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Automatic Switch Co.
2. Caterpillar, Inc.
3. Onan Corp.
4. Russelectric, Inc.
5. GE Zenith.

2.2 TRANSFER SWITCH PRODUCTS, GENERAL

A. Number of Poles and Current and Voltage Ratings: As indicated.

1. Units smaller than 600 amperes shall not have different current ratings for different classes or mixtures of loads, including 100 percent tungsten filament lamp or 100 percent inductive load.
2. Units 600 amperes and larger shall have current ratings that apply to mixtures of loads including 30-percent-maximum tungsten filament lamp load.

B. Tested Fault-Current Ratings: Closing and withstand ratings shall exceed the indicated available rms symmetrical fault current at the equipment terminals based on testing according to UL Standard 1008, conducted at full-rated system voltage and 20 percent power factor. Rate each product for withstand duration time as follows when tested for rated short-circuit current correlated with the actual type of circuit protective device indicated for transfer switches for this project.

C. Annunciation and Control Interface Components: Devices at transfer switches for communicating with remote annunciators or annunciator/control panels shall have communications capability matched with the remote device.

D. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20°C to 60°C.

E. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage surge withstand capability requirements when tested according to ANSI C37.90.1, IEEE Guide for Surge Withstand Capability (SWC) Tests. Components meet or exceed voltage impulse withstand test of NEMA ICS 1.
F. Neutral Terminal: Where 2- or 3-pole switches are indicated, provide fully rated, solid, unswitched neutral terminal except as indicated.

G. Four-Pole Switches: Where 4-pole switches are indicated, provide full-capacity neutral switching.

H. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated shall be double the nominal rating of the switch.

2.3 CONSTRUCTION

A. Transfer switches shall be double-throw, electrically and mechanically interlocked, and mechanically held in both positions.

B. Transfer switches rated through 1000 amperes shall be equipped with permanently attached manual operating handles and quick-break, quick-make over-center contact mechanisms suitable for safe manual operation under load.

C. Main switch contacts shall be high-pressure silver alloy. Contact assemblies shall have arc chutes for positive arc extinguishing. Arc chutes shall have insulating covers to prevent interphase flashover. Provide one set Form C auxiliary contacts on both sides, operated by transfer switch position, rated 10 amps 250 VAC.

D. Transfer switches designated on the drawings as 4-poles shall be provided with a switched neutral pole. The neutral pole shall be of the same construction and have the same ratings as the phase poles. All poles shall be switched simultaneously using a common crossbar. Equipment using add-on accessory overlapping contacts are not acceptable.

E. Transfer switches which are designated on the drawings as 3-pole shall be provided with a neutral bus and lugs, sized to carry 100% of the current designated on the switch rating.

F. Enclosures shall be UL listed. The enclosure shall provide NEC wire bend space. The cabinet door shall be key-locking. Controls on cabinet door shall be key-operated.

G. Transfer switches shall be mounted in enclosures as designated on the drawings. Separate enclosures shall be the NEMA type specified. The cabinet shall provide required wire bend space at point of entry as shown on the drawings. Manual operating handles and all control switches (other than key-operated switches) shall be accessible to authorized personnel only by opening the key-locking cabinet door. Transfer switches with manual operating handles and/or non key-operated control switches located on outside of cabinet do not meet this specification and are not acceptable.

2.4 AUTOMATIC CONTROLS

A. Transfer switches that are designated on the drawing as automatic shall be provided with a fully automatic control system, and provisions for manual operation as described in this section.

1. Control shall be solid-state and designed for a high level of immunity to power line surges and transients, demonstrated by test to IEEE Standard 472, NEMA ICS-109.21 and
IEC 801-2, 3 and 4. The control shall have optically isolated logic inputs, high isolation transformers for AC inputs, and relays on all outputs.

2. Solid-state under voltage sensors shall simultaneously monitor all phases of both sources. Pick-up and drop-out settings shall be adjustable. Voltage sensors shall allow for adjustment to sense partial loss of voltage on any phase. Voltage sensors shall have field calibration of actual supply voltage to nominal system voltage.

3. Controls shall be provided with a solid-state over and under frequency sensor to monitor source(s). Pickup bandwidth shall be adjustable from a minimum of +/-4% to a maximum of +/- 20% of nominal frequency. Dropout shall be +/-5% of nominal wider than pickup frequency bandwidth. Adjustable time delay shall be from 0.1 to 15 sec. Automatic controls shall signal the engine-generator set to start upon signal from normal source sensors. Solid-state time delay start, adjustable from 0 to 5 seconds (factory set at 2 seconds) shall avoid nuisance start-ups. Battery voltage starting contacts shall be gold, dry type contacts factory wired to a field wiring terminal block.

4. Provide Phase Sequence Monitor and Balance module to protect against inadvertent phase rotation hookup and monitor for voltage phase imbalance between phases.

5. The switch shall transfer when the emergency source reaches the set point voltage and frequency. Provide a solid-state time delay on transfer, adjustable from 0 to 120 seconds.

6. The switch shall retransfer the load to the normal source after a time delay retransfer, adjustable from 0 to 30 minutes. Retransfer time delay shall be immediately bypassed if the emergency power source fails.

7. Controls shall signal the engine-generator set to stop after a time delay, adjustable from 0 to 10 minutes, beginning on return to the normal source.

8. Power for transfer operation shall be from the source to which the load is being transferred.

9. The control shall include latching diagnostic indicators to pinpoint the last successful step in the sequence of control functions, and to indicate the present status of the control functions in real time, as follows:

   a. Source 1 OK
   b. Start Gen Set
   c. Source 2 OK
   d. Transfer Timing
   e. Transfer Complete
   f. Retransfer Timing
   g. Retransfer Complete
   h. Timing for Stop

10. Transfer switches shall be equipped with a field adjustable controls to allow the operator to control the transfer switch operating time during switching in both directions. The controls shall control the time the load is isolated from both power
sources, to allow load residual voltage to decay before closure to the opposite source. The transfer switch operating speed control feature shall have an adjustable range of 0 to 7.5 seconds. Phase angle monitor is not acceptable substitute for this feature.

2.5 FRONT PANEL DEVICES

A. Provide devices mounted on cabinet front consisting of:

1. A key-operated selector switch to provide the following positions and functions:
   a. Test - Simulates normal power loss to control for testing of generator set. Controls shall provide for a test with or without load transfer.
   b. Normal - Normal operating position.
   c. Retransfer - Momentary position to override retransfer time delay and cause immediate return to normal source, if available.

2. Transfer switch position and source available lamps.

2.6 ACCESSORY ITEMS

A. Transfer switches shall be equipped with accessories as follows:

1. Exerciser Clock: Provide solid state exerciser clock to set the day, time, and duration of generator set exercise/test period. Provide a with/without load selector switch for the exercise period.
2. Manual Selector Switch: Provide a manual/automatic retransfer selector switch to provide either automatic retransfer after the retransfer time delay, or a manual retransfer when selected by an operator.
3. Load side metering and CT's.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mounting of Switches: Level and anchor the unit to the wall, if wall mounted type. If floor mounted type, provide a 4" high housekeeping pad, rated for seismic conditions, level and anchor the unit to the pad.

B. Identify components according to Division 26 Section “Basic Electrical Materials and Methods.”

C. Installation shall comply with applicable state and local codes as required by the Authority Having Jurisdiction (AHJ). Install equipment in accordance with manufacturer’s instruction and instructions included in the listing and labeling of the UL listed products.

D. Installation of equipment shall include furnishing and installing all interconnecting wiring between components of the on-site power system.

3.2 WIRING TO REMOTE COMPONENTS

A. Match type and number of cables and conductors to control requirements of transfer switches used. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.
3.3 CONNECTIONS

A. Tighten factory-made connections, including connectors, terminals, bus joints, mountings and grounding. Tighten field-connectors and terminals, including screws and bolts, according to equipment manufacturer’s published torque tightening values. When manufacturer’s torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and 486B.

3.4 ADJUSTMENTS

A. Transfer switch units are shipped with time delay settings preset at factory. Field adjust these settings to correspond to field conditions.

B. Coordinate time delay settings with Owner to correlate with other settings of emergency electrical system equipment, either new or existing.

3.5 GROUNDING

A. Make equipment grounding connections for transfer switch units as indicated and as required by the NEC.

3.6 FIELD QUALITY CONTROL

A. Manufacturer’s Field Services: Provide services of a factory-authorized service representative to supervise field tests. Coordinate scheduling of tests with Owner’s Representative at least three weeks prior to the tests.

B. Preliminary Tests: Perform electrical tests as recommended by manufacturer and as follows:

1. Measure phase-to-phase and phase-to-ground insulation resistance levels with insulation resistance tester. Include external annunciator and control circuits. Use test voltages and procedure recommended by manufacturer. Meet manufacturer’s specified minimum resistance.

2. Check for electrical continuity of circuits and for short circuits.

C. Field Tests: Give 7 days’ advance notice of tests and perform tests in presence of Owner’s representative.

D. Coordinate tests with tests of generator plant and run them concurrently.

E. Tests: As recommended by manufacturer and as follows:

1. Contact Resistance Test: Measure resistance of power contacts for automatic transfer switches, non-automatic transfer switches and bypass/isolation switches. Resolve values in excess of 500 micro-ohms and differences between adjacent poles exceeding 50 percent.

2. Operational Tests: Demonstrate interlocking sequence and operational function for each switch at least 3 times.

   a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
b. Simulate low phase-to-ground voltage for each phase of normal source to automatic transfer switches.
c. Verify time-delay settings and pickup and dropout voltages.

F. Test Failures: Correct deficiencies identified by tests and prepare for retest. Verify that equipment meets specified requirements.

G. Reports: Maintain a written record of observations and tests. Report defective materials and workmanship and retest corrected items. Record adjustable relay settings and measured insulation and contact resistance and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.7 ON-SITE ACCEPTANCE TEST

A. The complete installation shall be tested for compliance with the specification following completion of all site work. Testing shall be conducted in conjunction with representatives of the manufacturer. The Engineer shall be notified in advance and shall have the option to witness the tests.

B. Installation acceptance tests to be conducted on-site shall include a "cold start" test, a two hour full load test, and a one-step rated load pickup test in accordance with NFPA 110 for the generator set and ATS. Electrical contractor shall be responsible to provide fuel for the genset to complete all testing and refill the genset tank upon test completion.

C. Coordinate test times with owner’s representative and maintain emergency system availability for the other buildings on site.

END OF SECTION 260620
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SECTION 26 07 21 – FIRE ALARM SYSTEMS - ADDRESSABLE

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes addressable fire alarm systems.

1.2 RELATED DOCUMENTS

A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.
B. Section 260000 Basic Electrical Requirements
C. Section 260010 Basic Electrical Materials and Methods

1.3 QUALITY ASSURANCE

A. The equipment and installation shall comply with the current applicable provisions of the following standards:
   1. National Electrical Code, NFPA 70
   2. National Fire Alarm Code, NFPA 72
   3. Carbon Monoxide Warning Equipment in Dwellings, NFPA 720
   4. International Building Code, IBC
   5. Life Safety Code, NFPA 101
   6. UL 864, 9th Edition Listed and Factory Mutual Approved
   7. ADA and ANSI A117.1
   9. Applicable Local and State Building codes
   10. Requirements of the Local Authority Having Jurisdiction

B. Equipment Supplier Qualifications
   1. The fire alarm equipment supplier shall have a NICET level 4 certified individual on staff responsible for overseeing the technical design and engineering functions related to the fire alarm system. The current NICET level 4 certificate number must be submitted to the engineer with shop drawings submittals.
   2. The fire alarm equipment supplier shall have on staff NICET level 2 technicians supervising the final connections and programming of the system.
   3. The equipment supplier must be an authorized distributor/dealer of the equipment being provided. The supplier must be factory authorized to service under warranty the components furnished. Two stepping of equipment from a “box house” or out of area distributor is not allowed.
   4. Fire Alarm Contractor shall be capable of providing signed and sealed shop drawings for the fire alarm system, by a Professional Engineer of the State in which the project is located.

1.4 SUBMITTALS

19-2726.01 & 19-2727.01
A. Shop Drawings

1. The Contractor shall provide complete fire alarm system documents signed and sealed documents by a Professional Engineer of the State in which the project is located as follows:
   
   a. Battery calculations
   b. Voltage drop calculations
   c. Wiring details and diagrams including types and sizes
   d. Location of FACP, power supplies, DACT, annunciators, power connections, etc
   e. Floor plan indicating use of each room, ceiling heights and construction
   f. Fire alarm matrix and interface of the fire safety controls functions
   g. Equipment, device and material cutsheets and technical details including but not limited to the model number, listing info, type, rating, size, style, for all items.
   h. Complete list of deviations, exceptions and variations from the Contract Documents related to the fire alarm system and associated equipment and systems.

2. The fire alarm shop drawings will be returned incomplete if signed and sealed documents as outlined above are not submitted. Engineer will provide a preliminary shop drawing review for general conformance prior to submitting final signed and sealed drawings upon request.

3. In the event a separate fire alarm permit/review is required, the signed and sealed Contractor shop drawings are to be submitted to SSC Engineering for review prior to SSC Engineering providing any signed and sealed fire alarm Contract Documents.

4. It is the responsibility of the Contractor to provide the above information in a timely fashion to accommodate the construction schedule.

5. Provide proof of authorization from equipment manufacturer for being a dealer and NICET certificates. The current NICET level 4 certificate number must be submitted to the engineer with shop drawings submittals. Shop drawing will be rejected if a current NICET certificate is not submitted.

6. Provide proof of authorization from equipment manufacturer for being a true authorized distributor/dealer for service and warranty as well as NICET certificates.

B. Record Drawings

1. Provide one complete set of as-built record drawings following project completion. The drawings shall include:
   
   a. Routing of conduit and all wiring from each device, i.e. smoke detector, signaling appliance, etc. to the control panel, or remote power supply.
   b. Clearly identify each indicating appliance circuit, initiating or SLC circuit, control circuit, etc. and quantity of conductors.
   c. Device location and identification number, control panel, circuit breaker and end-of-line resistor locations.
2. Provide one complete set of Operations and Maintenance Manuals, including completed Initial Acceptance Test form, Record of Completion form, and final submittal documents.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The FACP shall be a Notifier NFS-320 or approved equal and shall contain a microprocessor based Central Processing Unit (CPU). The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent detectors, addressable modules, annunciators and other system controlled devices. The panel shall be UL listed as a Fire Alarm Control Panel per UL 864, 9th Edition.

B. Equal systems by Simplex, Siemens, or Gamewell-FCI shall be considered approved equals provided the systems meet all performance requirements of these specifications.

2.2 SYSTEM GENERAL OPERATION

A. System Alarm Detection

1. When a fire alarm condition is detected and reported by one of the system initiating devices, the following functions shall immediately occur:

   a. The System Alarm LED shall flash.
   b. A local signal in the control panel shall sound.
   c. The 80-character LCD display shall indicate all information associated with the Fire Alarm condition, including: type of alarm point, its location within the protected premises and the time and date of that activation.
   d. All system output programs assigned via control-by-event equations to be activated by the particular point in alarm shall be executed including:

      1) Alarm Indicating appliances.
      2) Control relays for general air handler shutdown.
      3) Control relays to recall and shut down power to the elevators per ASME A17.1 requirements.
      4) Central station outputs for connection digital communicator:

         a) Alarm
         b) Trouble
         c) Supervisory

2. The Microprocessor unit shall contain and execute all control by event programs for specific action to be taken if an alarm condition is detected by the system. Such control by event programs shall be held in nonvolatile programmable memory and shall not be lost even if system primary and secondary power failure occurs.

3. All programming of the system may be achieved without special equipment or lap top computers and without interrupting the alarm monitoring functions of the Fire Alarm Control Panel. If special hardware or software is required to program the system it must
be included in this contract and be provided to the owner at time of delivery and the owner must be trained on the programming of the system.

4. Program edit shall not interfere with normal operation and fire protection. If a fire condition is detected during programming operation, the system shall exit programming and perform fire protection functions as programmed.

5. Provide a battery back-up and charging system for 24 hours of standby and 5 minutes of alarm for the entire fire alarm system.

B. Special FACP Features

1. The FACP shall provide the following features:
   a. Drift Compensation to extend detector accuracy over life.
   b. Sensitivity Test, meeting requirements of NFPA 72.
   c. Maintenance Alert to warn of excessive compensation.
   d. System Status Reports to display or printer.
   e. Alarm Verification, with verification counters.
   f. Non-Alarm points for general (non-fire) control.
   g. Periodic Detector Test, conducted automatically by software.
   h. Walk Test, with check for two detectors set to same address.
   i. Control by Time for non-fire operations, with holidays.
   j. Day/Night automatic adjustment of detector sensitivity.

C. Control Panel Switches

1. Acknowledge Switch
   a. Activation of the control panel Acknowledge switch in response to new Alarms and/or Troubles shall silence the local panel piezo electric signal and change the Alarm and Trouble LEDs from flashing mode to steady ON mode. If multiple Alarm or Trouble conditions exist, depression of this switch shall advance the 80 character LCD display to the next Alarm or Trouble condition. Depression of the Acknowledge switch shall also silence all remote annunciator piezo sounders.

2. Signal Silence Switch
   a. Activation of the Signal Silence Switch shall cause all programmed Alarm Indicating Appliances and relays to return to the normal condition after an alarm condition. The selection of indicating circuits and relays that are silence able by this switch shall be fully field programmable within the confines of all applicable standards. The FACP software shall include silence inhibit and auto-silence timers.

3. System Reset Switch
   a. Activation of the System Reset Switch shall cause all electronically latched initiating devices, appliances or software zones, as well as all associated output devices and circuits, to return to their normal condition. Holding the RESET switch shall perform a Lamp Test function.
4. Drill (Evacuate) Switch
   a. Press and hold of the Drill switch shall activate all Indicating Appliance circuits. The Drill function shall latch until press of Signal Silence or Reset.

D. SLC Loop Interface
   1. The SLC Interface shall provide power to, and communicate with, all of the Intelligent/Addressable Detectors and Addressable Modules over a single pair of wires.
   2. The Loop Interface Board shall receive analog information from all Intelligent Detectors that shall be processed to determine whether normal, alarm or trouble conditions exist for each detector. The software shall automatically maintain the detector’s desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information may also be used for automatic detector testing and for the automatic determination of detector maintenance requirements.
   3. The detector software shall meet NFPA 72 requirements and be certified by UL as a calibrated sensitivity test instrument.
   4. Provide dedicated loops as required to accommodate design requirements.

E. System History Recording and Reporting
   1. The Fire Alarm Control Panel shall contain a History Buffer that will be capable of storing up to 400 system alarms/troubles/operator actions. Each of these activation's will be stored and time and date stamped with the actual time of the activation. The contents of the History Buffer may be manually reviewed, one event at a time.
   2. The History Buffer shall use non-volatile memory. Systems that use volatile memory for history storage are not acceptable.

F. The Fire Alarm Control Panel shall include a full featured operator interface control and annunciation panel which shall include a backlit 80 character Liquid Crystal Display, individual, color coded system status LEDs and an alpha-numeric keypad for the Field Programming and Control of the Fire Alarm System.

G. The remote fire alarm annunciator shall include a full featured operator interface control and annunciation panel which shall include a backlit 80-character liquid crystal display; individual color coded system status LEDs and an alpha-numeric keypad for the field programming and control of the fire alarm system. Notifier model N-ANN-80.

H. Maintenance Functions
   1. Smoke Detector Sensitivity Adjust
      a. Means shall be provided for adjusting the sensitivity of any or all analog intelligent detectors in the system from the System keypad. Sensitivity range be will be within the allowed UL window and shall be HIGH/MEDIUM/LOW selection.
2. Alarm Verification
   a. Each of the Intelligent/Addressable Smoke Detectors in the system shall be alarm verified. The Alarm Verification Function shall be from 5-50 seconds and each detector shall be able to be enabled/disabled during the field programming of the system, or any time after system turn-on.

3. Automatic Detector Maintenance Alert
   a. The Fire Alarm Control Panel shall automatically interrogate each Intelligent Smoke Detector and shall analyze the detector responses over a period of time. If any Intelligent Smoke Detector in the system responds with a reading that is below or above normal limits, then the system will enter the Trouble Mode and the particular Detector will be annunciated on the System Display. This feature shall in no way inhibit the receipt of Alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.

2.3 FIELD DEVICES

A. Addressable Manual Stations
   1. Addressable Manual Stations shall be provided to connect one addressable, supervised Manual Station to one of the Fire Alarm Control Panel Signaling Line Circuit (SLC) Loops. The Manual Station shall, on command from the Control Panel, send data to the panel representing the state of the manual switch. Manual Fire Alarm Stations shall be crush tube type with a key operated test-reset lock. Notifier model NBG-12LX with SB-I/0 as required.

B. Automatic Fire Detectors
   1. Analog Addressable Photoelectric Type Smoke Detectors
      a. The Photoelectric-Type Smoke Detectors shall be Intelligent and Addressable and shall connect with two wires to one of the Fire Alarm Control Panel Signaling Line Circuit Loops. The detectors shall use the light obscuration principal to measure products of combustion and shall, on command from the control panel, send data to the panel representing the analog level of products of combustion.

      b. The detectors shall be ceiling-mount and shall include a twist-lock base. The detectors shall provide address-setting means on the detector head using rotary decimal switch and shall also store an internal identifying code which the control panel shall use to identify the type of detector. An output connection shall also be provided in the base to connect an external remote alarm LED. The detector sensitivity shall be set through the Fire Alarm Control Panel and shall be adjustable in the field through the field programming of the system. Notifier model FSP-951 with B300-6 standard base.

   2. Analog Addressable Heat Detectors
      a. The Intelligent Heat Detectors shall be Intelligent and Addressable and shall connect with two wires to one of the Fire Alarm Control Panel Signaling Line Circuit Loops. The Detectors shall use the heat principle to measure products of combustion and shall, on command from the control panel, send data to the panel representing the analog level of products of combustion. The detectors shall be adjustable in the field through the field programming of the system. Notifier model FSP-951 with B300-6 standard base.
Circuit Loops. The detectors shall use an electronic sensor to measure thermal conditions caused by a fire and shall, on command from the control panel, send data to the panel representing the analog level of such thermal measurements.

b. The detectors shall be ceiling-mount and shall include a twist-lock base. The detectors shall provide address-setting means on the detector head using rotary decimal switch and shall also store an internal identifying code, which the control panel shall use to identify the type of detector. Notifier FST-951, 135 degree fixed thermal detector or FST-951H, 190 degree fixed thermal detector with B300-6 standard base.

3. Analog Single/Multiple Station Photoelectric Type Smoke Alarms

a. The single/multiple station photoelectric type smoke alarms shall connect to 120V power and shall have a 9VDC battery back-up with low or missing battery indicator. The alarms shall have a push button self-test feature. The alarms shall use the light obstruction principal to measure products of combustion. Each single/multiple station smoke alarm shall be provided with (1) dry type Form C contact that activates upon detection, even when on battery back-up. Notification shall be a Temporal 3 audible signal rated at 85 dBA at 10 feet.

b. The alarms shall have tandem interconnect capability of up to 12 other alarms. The alarm shall have interconnect capability with other single/multiple station devices including but not limited to smoke alarms, carbon monoxide alarms and combination smoke and carbon monoxide alarms. Tandem interconnected units shall signal Temporal 3 for smoke and Temporal 4 for carbon monoxide.

c. The alarms shall be ANSI/UL 217 listed for both ceiling and wall mounting, equivalent to Gentex S1209F.

4. Analog Single/Multiple Station Carbon Monoxide Alarms

a. The single/multiple station carbon monoxide alarms shall connect to 120V power and shall have a 9VDC battery back-up with low or missing battery indicator. The alarms shall have a push button self-test feature. The alarms shall utilize an electrochemical sensing element with a minimum 5-year life. The alarms shall have an end of life signal which indicates the CO sensor has reached its depletion state. Each single/multiple station alarm shall be provided with (1) dry type Form C contact that activates upon detection, even when on battery back-up. Notification shall be a Temporal 4 audible signal rated at 85 dBA at 10 feet.

b. The alarms shall have tandem interconnect capability of up to 12 other alarms. The alarm shall have interconnect capability with other single/multiple station devices including but not limited to smoke alarms, carbon monoxide alarms and combination smoke and carbon monoxide alarms. Tandem interconnected units shall signal Temporal 3 for smoke and Temporal 4 for carbon monoxide.

c. The alarms shall be ANSI/UL 2034 listed for both ceiling and wall mounting, equivalent to Gentex CO1209F.
5. Analog Single/Multiple Station Combination Photoelectric Type Smoke and Carbon Monoxide Alarms

a. The single/multiple station combination photoelectric type smoke and carbon monoxide alarms shall connect to 120V power and shall have a 9VDC battery back-up with low or missing battery indicator. The alarms shall have a push button self-test feature.

b. The smoke alarm portion shall use the light obstruction principle to measure products of combustion.

c. The carbon monoxide portion shall utilize an electrochemical sensing element with a minimum 5-year life. The carbon monoxide portion shall have an end of life signal which indicates the CO sensor has reached its depletion state.

d. Each single/multiple station alarm shall be provided with (1) dry type Form C contact that activates upon alarm. Where indicated on drawings, provide (2) sets of contacts that activate independently for smoke and CO events. Contact(s) shall operate even when on battery backup. Notification shall be Temporal 3 for smoke and Temporal 4 for carbon monoxide and rated 85 dBA at 10 feet.

e. The alarms shall have tandem interconnect capability of up to 12 other alarms. The alarm shall have interconnect capability with other single/multiple station devices including but not limited to smoke alarms, carbon monoxide and combination smoke and carbon monoxide alarms. Tandem interconnected units shall signal Temporal 3 for smoke and Temporal 4 for carbon monoxide.

f. The alarms shall be ANSI/UL 217 and ANSI/UL 2034 listed for both ceiling and wall mounting, equivalent to Gentex GN-503F (one set of Form C contacts) or GN-503FF (two sets of Form C contacts).

C. Remote Fire Alarm Annunciator Panel (FAAP):

1. The remote fire alarm annunciator shall include a full featured operator interface control and annunciator panel which shall include a backlit 80-character liquid crystal display; individual color coded system status LEDs and an alpha-numeric keypad for the field programming and control of the fire alarm system. Notifier model N-ANN-80.

D. Control Module

1. Control Modules shall be provided to supervise and control the operation of one signal circuit or as an addressable Dry Contact (Form C) Relay for elevator and air handler control. The Control Module shall provide address-setting means using rotary decimal switches and shall also store an internal identifying code which the Control Panel shall use to identify the type of device. Notifier model FCM-1 or FRM-1

E. Monitor Module

1. Monitor modules shall be provided to connect any N.O. dry contact device (water flow, tamper switches and kitchen hood) to the Fire Alarm Control Panel Signaling Line Circuit Loop. The Monitor module shall provide address-setting means using rotary decimal
switches and shall also store an internal identifying code which the Fire Alarm Control Panel shall use to identify the type of device. Notifier model FMM-1, FMM-101 or FDM-1 (Dual).

F. Horn Strobes

1. Audible signals shall be all-electronic and shall not require vibrating solenoids or contacts. They shall be 24 VDC polarized and meet UL 1971. Mounting shall be semi-flush using standard back boxes. The visual section shall be 24 VDC polarized Xenon strobe with FIRE lettering clearly visible. The horn shall include a high/low switch to provide 100 dBA (high) or 94 dBA (low) sound pressure based on anechoic chamber measurements. Set on low volume setting in small rooms, stairwells and restrooms. The horn output shall be switch selectable between a continuous tone or Temporal Code 3 tone. Set tone to Temporal Code 3 pattern. Provide signals based on the following types (verify white housing is acceptable with AHJs prior to ordering.):

2. Provide weatherproof appliance and back box when installed exterior to the building, within wet locations or wherever located outside the listed environment of the “standard” notification appliance.

G. Low Frequency Sounders and Combination Sounder/Strobes

1. Audible signals shall be all-electronic and shall not require vibrating solenoids or contacts. They shall be 24 VDC polarized and meet UL 464 and UL 1971. Mounting shall be semi-flush using standard back boxes. The sounder shall provide 86 dBA (high) sound pressure based on anechoic chamber measurements with a 520 Hz square wave tone. The horn output shall be switch selectable between a continuous tone or Temporal Code 3. Set tone to Temporal Code 3 pattern. Provide devices equivalent to the following signal types:
   a. Audible signal: System Sensor HR-LF (use HW-LF if white is acceptable to AHJ.)
   b. Audible/Visual: System Sensor P2RH-LF (use P2WH-LF if white is acceptable to AHJ), set candela rating to 177.

H. Remote Power Supplies

1. Signaling appliance remote power supplies shall be UL listed for fire alarm signaling and provide 6 amps of 24 VDC power. The power supply shall include 4 style Y notification appliance circuits. Provide two 7.0 amp hour batteries with each power supply. Remote power supply shall be Notifier model FCPS-24S6 or Potter PSN-106B. Provide as required for audible/visual signals.

I. Central Monitoring Equipment shall be UL listed and include a commercial fire digital communicator complete with the following features:
1. Meet NFPA 72 requirements for Digital Alarm Communicator Transmitter.
2. Capable of seizing the proper communication method at the protected premises, disconnecting an outgoing or incoming call and preventing its use until signal transmission has been completed.
3. Contain a minimum of 4 channels.
4. Connected to two separate communication methods at protected premises.
5. Capable of selecting the operable communication method in the event of a failure on either method.
6. Programmed to utilize the alternate method should the signal transmission be unsuccessful.
7. Equipped with battery pack, charger, telephone jack and dedicated 120 VAC receptacle.
8. The digital communicator shall be connected to the fire alarm system to receive and transmit alarm signals, trouble conditions and supervisory conditions. Digital Communicator shall be Notifier model 411UDAC. Monitoring service and communicator programming shall be furnished by owners monitoring company.
9. Provide a dual path communicator module/device that utilizes IP communication and cellular (GSM or CDMA) communication. Provide programming, cables and connectors as required. Owner to provide active data port.
10. Provide cable, connectors and installation of two CO telephone lines and interface in accordance with FCC Part 68 using a USOC-RJ31-X jack. The owner shall furnish two standard business lines for this purpose.

PART 3 - EXECUTION

3.1 POWER SOURCE

A. The Fire Alarm Control Panel shall be connected to a separate dedicated 120 volt, 20 Amp branch circuit. This circuit shall be labeled at the Electrical Panel as FIRE ALARM.

B. The fire alarm remote power supplies shall be connected to a dedicated 120 volt, 20 amp branch circuit labeled as FIRE ALARM. Provide required quantities of power supplies and circuits as required.

3.2 WIRING

A. Wiring will be as required by the Equipment Supplier. Wire color coding and the color shall remain the same throughout the system. In general, all initiating devices such as manual stations, thermal detectors and smoke detectors shall be installed across a common #18 AWG twisted shielded pair. The signal circuits shall require #14 AWG. All system wiring shall be plenum rated wire. The ground will be minimum one #6 AWG insulated copper. Provide conduit with insulated bushing in wall from device up to accessible ceiling.

B. Provide surge protection devices on all circuits that enter the building from the exterior. Surge suppression shall be equivalent to Ditek.

3.3 TESTING

A. The operation of the Fire Alarm System shall be checked by a representative of the equipment supplier. At the final inspection, a factory-trained representative of the manufacturer of the
equipment shall demonstrate that the system functions properly in every respect. A report describing the test results shall be submitted to the Engineer.

B. The system will not be accepted until final testing and receipt of the NFPA 72 Inspection and Testing Form has been obtained and approved.

C. System shall be tested and installed to maintain the UL “UUFX” listing as required by the AHJ, Fire Protection District or Fire Department.

3.4 INSTRUCTION

A. Instruction shall be provided as required for operating the system. Hands-on demonstrations of the operation of all system including changes and functions shall be provided.

B. The contractor and/or the systems manufacture’s representatives shall provide a type written “sequence of operation” to allow the owner to silence reset and acknowledge the fire alarm control panel.

C. Provide a minimum of eight (8) hours training for staff personnel in the operation and maintenance of the system.

3.5 INSTALLATION

A. In order to assure compliance with the NFPA Standards and manufacturers requirements the fire alarm equipment supplier to the electrical contractor must perform the following functions:

1. Install and connect each and every detector, signaling appliance, pull station, control/monitor module, annunciator etc., excluding the rough-in and cabling between the devices.

2. The electrical contractor shall install rough-in and cable between rough-in points as required by the fire alarm system supplier. Rough-in includes control panel back boxes, remote power supply back boxes and digital communicator back boxes.

3. The electrical contractor shall provide any conduit, all required back boxes, 120 volt power and connections of the 120 volt power as required by the fire alarm equipment supplier to meet the functionality specified herein.

4. Subcontracting by the fire alarm equipment provider to perform the field device installation and connections is not acceptable.

5. 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.

6. All wires shall be tagged at all junction points and shall test free from grounds or crosses between conductors.
7. No other conductors shall be installed in conduits with conductors for the fire alarm system.

8. Smoke detectors shall be protected from construction dust until after the construction clean-up of all trades is complete and final. Detectors that have not been protected prior to final clean-up by all trades shall be cleaned or replaced.

9. A UL Certificate or FM Placard, per NFPA 72, shall be issued by the UL Listed or FM Approved contractor for all newly installed, required fire alarm systems.

B. Equipment Mounting

1. The control panel shall be flush mounted with no operational parts which may require maintenance mounted greater than 72-inches above the finished floor. The control panel annunciator shall be mounted so that no switch, manually operated device, display or LED is greater than 60-inches above the finished floor.

2. Duct detectors shall be provided under this section and will be mounted by the HVAC contractor at the supply side of all HVAC units of 2,000 cfm or greater and at the return side of all HVAC units of 2,000 cfm or greater per NFPA 90A and IMC, or as shown on the drawings. Supervise and coordinate placement by HVAC contractor and connect all circuits. Duct detectors shall be mounted in such a way as to obtain a representative sample of the airstream. The duct detectors shall be located in the zone between 6 and 10 duct widths from any duct bends or inlets. When located at duct openings, use spot detectors mounted as required by NFPA 72 for duct openings. Detectors shall be accessible for cleaning and shall be mounted in accordance with the manufacturer’s instructions and NFPA standards.

3. Fire smoke damper provide a spot detector pendant mounted in the duct with an access panel for maintenance and testing.

4. All HVAC equipment shutdown and smoke control functions shall be initiated by addressable control module interface with the EMS system. Relays shall be mounted within three (3) feet of the EMS interface equipment.

5. 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.

6. The manual pull station(s) shall be securely mounted with the operable part of the manual pull station at 46-inches above the finished floor.

7. Wall mounted audible/visual, audible and/or visual devices shall be mounted with their bottoms at 80-inches above the finished floor or 6-inches below the ceiling, whichever is lower.

8. Devices shall not be supported by ceiling tiles. Devices must be attached to a back-box supported by the ceiling grid.

9. At each door (man, overhead, counter, etc.) with magnetic hold opens, provide smoke detector(s) located in accordance with NFPA 72, whether shown on plans or not.
C. Painting and Patching

1. All fire alarm conduit shall be thoroughly cleaned, removing all dirt, oil, etc. and made ready to receive paint.

2. Holes in walls or floors cut during the performance of this work shall be patched or covered with standard escutcheon plates so as to completely conceal the cuts where they would otherwise be exposed to view.

3. Firestop all penetrations of fire rated assemblies.

END OF SECTION 260721
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SECTION 26 07 24 – TELEVISION SYSTEM ROUGH-IN

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This specification is for the rough in of the following television systems:

1. Cable TV System

B. Extent of television (TV) systems work is indicated by drawings.

C. This contract requires the furnishing and installation of conduit, boxes, cable, cable terminal cabinet, and the providing of a 120 volt power circuit for the terminal cabinet.

PART 2 - PRODUCTS

2.1 Provide conduit and boxes, as specified in Section 260110.

2.2 Cable shall be RG6/U quad shield coaxial cable; 75-ohm characteristic impedance; with copper inner conductor; outer conductor braided aluminum wire; cellular polyethylene low density dielectric cove; with black vinyl jacket; and 100 percent sweep tested. Cable shall be plenum rated unless installed in conduit.

PART 3 - EXECUTION

3.1 Provide raceways and boxes as shown on the drawings. This shall include two-gang boxes with single-gang raised cover and 1 inch empty conduit with insulated bushing roughed into an accessible ceiling.

3.2 Pull cable(s) from main terminal board or enclosure and terminate at wall jacks.

3.3 All empty conduits shall be provided with a pull wire.

END OF SECTION 260724
SECTION 26 07 62 – DATA EQUIPMENT AND WIRING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Provisions of Division 01 apply to this section.

B. Work in this section include but are not limited to:

1. Furnishing, installation, testing and documentation of all elements for Owner’s local area network (LAN) cable infrastructure.
2. Furnishing all labor and materials to meet product performance requirements, general design considerations and installation guidelines.
3. Responsibilities for labor, supervision, tooling, miscellaneous mounting hardware, cable management software, and consumables for systems installed.

1.2 RELATED SECTIONS

A. Section 260000 - Basic Electrical Requirements.

B. Section 260010 - Basic Electrical Materials and Methods.

1.3 ACRONYMS

B. BICSI - Building Industry Consulting Services International.
C. BBS - Backbone Data Switch.
D. DHCP - Dynamic Host Configuration Protocol.
E. EIA - Electronic Industries Alliance.
F. ESM - Edge Data Switch - Managed.
G. ESU - Edge Data Switch - Unmanaged.
H. FEP - Fluorinated Ethylene Propylene.
I. HVAC - Heating, Ventilation and Air Conditioning.
J. IDF - Intermediate Distribution Frame.
K. IEEE - Institute of Electrical and Electronic Engineers.
L. IP - Internet Protocol.
M. ISA - Industry Standard Architecture.
N. ISM - Intermediate Data Switch - Managed.
O. LAN - Local Area Network.
P. LDF - Local Distribution Frame.
Q. LIU - Light Interconnection Unit. (Also FTU - Fiber Terminating Unit).
R. MDF - Main Distribution Frame.
S. MPOP - Main Point of Presence. (Also MPOE - Main Point of Entry).
T. NEC - National Electrical Code
U. OFNR - Optical Fiber Non-Conductive Riser.
V. OTDR - Optical Time Domain Reflectometer.
X. UL - Underwriters Laboratories Inc.
Y. UPS - Uninterruptible Power Supply.
Z. UTP - Unshielded Twisted Pair.

1.4 SYSTEM REQUIREMENTS

A. Work shall include, but is not limited to the following:

1. Provide MDF and IDF cabinets/racks on project site as indicated on drawings. MDF shall be located as close to the MPOP as practical. IDF’s shall be located in designated spaces and in sufficient quantity to maintain compliance with the horizontal cable running distance limitations as specified in ANSI/TIA/EIA standard 568. Provide sufficient cabinet/rack space to allow a 50% expansion of the number of network data drops required by configuration as indicated on drawings. Leave space for at least one additional rack in the future.

2. Provide and install pathway and cabling from the MDF to the MPOE.

3. Furnish and install all appropriate LIU/FTU panels, connectors, patch cords, and cable management hardware internal to the cabinets/racks.

4. MDF and IDF’s shall consist of floor-mounted racks containing the space for data switches, UPS’s, patch panels, patch cords, connectors, and wire management as required to distribute data drops to each workstation.

5. Provide all pathways for horizontal and backbone cabling including J-hooks, cable tray, surface raceway, and/or conduit as indicated on drawings or as required per listed standards, whichever is more stringent.

1.5 SUBMITTALS

A. Provide the following submittals in accordance with Section 260000.

1. Material list: Submit a complete material list for the materials and products of this section. Each submittal shall be bound and shall contain an index.

2. Product Data: Include product data sheets and/or catalog cut sheets for items listed in index. Items shall be arranged in the same order as the index and if more than one item is indicated, the submitted items shall be highlighted or marked with an arrow. Product data shall be sufficiently detailed to allow the Engineer to review the product and to allow other trades to provide necessary coordination.

3. Shop Drawings: Provide shop drawings, in the same size as the drawings, prepared. Shop drawings shall indicate equipment locations, wiring schematics including point to point, panel and cabinet configurations, interfaces to equipment furnished by others, conduit and raceway sizes, cable counts, and termination locations. Background drawings may be obtained from the Architect in electronic version. Review shop drawings with Owners IT Representative.

B. Installation and coordination drawings for items in other sections shall be included with submittal of shop drawings.

1.6 CODE AND STANDARDS
A. UL
C. Occupational Safety and Health Association (OSHA) - National, state and local building and fire codes.
D. ANSI/TIA/EIA 455, standard Test Procedures for Fiber Optics, Current issue.
E. ANSI/TIA/EIA 526-14 Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.
F. ANSI/TIA/EIA-568, Commercial Building Telecommunications Cabling Standards and Addendums, current editions.
H. ANSI/EIA/TIA-598, Optical Fiber Cable Color Coding.
J. ANSI/TIA/EIA-607, Commercial Building Grounding and Bonding Requirements for Telecommunications, current issue.
L. TIA TSB-155, “Guidelines for the Assessment and Mitigation of Installed Category 6 Cabling to Support 10G Base-T”.
M. IEEE 802.3 (Ethernet), 802.3Z (Gigabit Ethernet over optical fiber), 802.3ab (Gigabit Ethernet over 4-pair Category 5 or higher).
O. FCC Part 68.50.
P. National Electrical Manufacturer’s Association (NEMA).
Q. NECA / FOA 301, “Standard for Installing and Testing Fiber Optic Cables.”

1.7 SYSTEM DESCRIPTION

A. Telecommunications Cabling Infrastructure

1. General: Network cabling infrastructure will utilize star topology design consisting of horizontal cabling, backbone cabling and various telecommunications cabling pathways and spaces. Following project drawings, Contractor shall determine the best route and
method for cable conveyance throughout the building in accordance with Owner standards.

2. Horizontal Cabling: Data outlets, unless otherwise noted, shall be furnished with two Cat 6, RJ45 receptacle. Cat 6 cables shall be terminated on 8-position, 8-conductor Cat 6 (RJ45) jacks wired in accordance with T568B. Associated faceplates shall accommodate four jacks at a minimum. Within the room, the cabling shall be routed via in-wall conduit or surface mount raceway into the data outlet as close to each workstation as practical. Provide extended sleeves to cross over hard tile ceiling areas and other inaccessible areas. Provide Cat 6 rated patch panels and all necessary patch cords for telecommunications spaces, cabinets and workstations to maintain a Cat 6 channel for horizontal cabling.

3. Backbone Cabling: The backbone cabling, unless otherwise noted, shall consist of 12-strand multi-mode and 6-strand single-mode fiber optic cabling for inter-building and intra-building backbone cabling. Connectors, optical fiber patch cords, distribution panels, ferrules, enclosures, cable tray, and consumables shall be included to provide backbone connectivity between each MDF and IDF.

4. Telecommunications Spaces: Telecommunications spaces shall be located in secure areas with 24 hr./7 day temperature control and ventilation, power, lighting, and grounding. MDF and IDF spaces will accommodate horizontal and backbone cabling termination equipment including free-standing cabinets/racks, patch panels, vertical and horizontal wire management, patch cables, ladder racking, conduit sleeves, and data electronics.

1.8 QUALITY ASSURANCE

A. The work of this section shall conform to applicable codes and standards.

B. The work of this section shall be provided by an installer that has completed at least 5 projects of equal scope to the specified systems and shall have been engaged in the business of supplying and installing the type of specified systems for at least 5 years. Include the telephone number of the customer’s client contact for each of the 5 projects.

C. Provide a 2 year material and labor warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Fiber optic and data cables shall be manufactured by Belden, Hitachi, Berk-Tek, Corning (fiber only) or approved equal.

B. Cabinets / racks, data inserts, patch panels, faceplates and other accessories shall be manufactured by Ortronics, Hubbell, Panduit, Leviton or approved equal.

2.2 EQUIPMENT STANDARDS

A. All components installed shall be listed by UL.
B. Equipment requirements

1. In order to establish a standard of quality as required by the Owner, various manufacturers’ equipment may meet the requirements in this document. As a reference for comparison of vendors, the equipment specification sheets on items shall be included with the submittal.

2. The Engineer will determine compliance of product or components offered for use under this Contract.

2.3 CABLING REQUIREMENTS

A. Underground pathways: Schedule 40 PVC conduit conforming to UL 651.

B. Interior Metallic Conduit:

1. Electric metallic tubing (EMT) shall be rated in accordance with UL 797.

2. Distribution cable shall be routed through an interior EMT wall sleeve from the data outlet to the interstitial ceiling space adjacent to the designated horizontal return, i.e. J-hooks and cable tray.

C. Cat 6 Cable: Horizontal cabling shall be 4-pair UTP, UL and NEC rated, with appropriately rated PVC jacket. Individual conductors shall be FEP insulated. Cable shall meet ANSI/TIA/EIA minimum requirements for return loss, propagation delay, delay skew, NEXT loss, PSNEXT loss, FEXT loss, ELFEXT and PSELFEXT for 4-pair Cat 6 cabling as detailed in ANSI/TIA/EIA-568-C.2.

D. Cable sheaths for analog telephone shall white and data shall be blue. Color shall be distinctly different from other twisted pair cable plants (e.g. cables for telephone or building automation systems). Cables for access control shall be gray. Cables for video surveillance shall be black. Cables exceeding 295 feet (90 meters) from horizontal cross-connect or patch panels to workstation outlets are not permitted.

E. Data Inserts: Data inserts shall be wired to the T568-B wiring pattern. Data inserts shall meet minimum requirements for return loss, propagation delay, delay skew, NEXT loss, FEXT loss, ELFEXT, and PSELFEXT for connecting hardware in accordance with ANSI/TIA/EIA-568.

F. Patch Cords: Patch cords shall be rated to match horizontal cabling. Patch cords shall be factory assembled by the manufacturer of the cabling system.

G. Patch Panels: Patch panels shall be provided in 24 or 48-port compliments with modular jack ports wired to T568-B. Patch panels shall be augmented with cable support bars in rear to properly dress cable. Patch panels shall meet minimum requirements for return loss, propagation delay, delay skew, NEXT loss, PSNEXT loss, FEXT loss, ELFEXT, and PSELFEXT for connecting hardware in accordance ANSI/TIA/EIA-568.

H. Outlet Gang Boxes: As a minimum, telecommunications outlet boxes shall be capable of housing 4 Cat 5e terminations. Telecommunications outlet/connector box shall consist of a 4”x4”x2-1/8” deep electrical box.

I. Faceplates: Faceplates shall be constructed of ABS molding compound and have the ability to accommodate four inserts or as required by cable terminations. Colors to be per LAUSD standards shall be similar receptacle outlets in Section 260140.
J. Floor-standing Cabinets: Floor-standing equipment cabinets for MDF or IDF installation use as required. If an MDF cabinet contains more than eight EIA rack spaces of structured cable components, a second floor-standing cabinet shall be provided. In the event that two cabinets are provided in the MDF, all structured cabling components shall be installed in the same cabinet. Cabinets shall provide at least 84 inches of total mounting space for 19-inch panels and 24 inches of interior depth. Cabinet shall be constructed of a minimum of 14 gage steel, with adjustable mounting rails tapped for No. 10-32 screws on EIA spacing front and rear, and shall be provided with Zone 4 earthquake reinforcing kits. Cabinet shall be provided with the following:

1. Thermostatically controlled heat dissipation fan.
2. Textured antique finish.
3. Matching side panels and louvered top panel.
4. Hinged, key-locking, removable bronze-tinted acrylic window door in front.
5. Full-length, removable hinged, key-locking rear door.
6. Both doors shall be able to swing fully open.

K. Wall-Mounted Cabinet: Wall-mounted equipment cabinets shall provide at least 45 inches of mounting space for 19-inch panels (26 rack spaces) and 24 inches of interior depth. No more than one third of the mounting space in a cabinet may be occupied by structured cable components. Cabinets shall be welded steel construction with 14 gage carbon steel mounting rails, tapped for No. 10-32 screws on EIA spacing, fully adjustable front-rear. Cabinets shall be provided with top or side ventilation capability and a thermostatically controlled heat dissipation fan, a plexi-glass front door, and locks on both front and rear sections, and shall be provided with white, powder coat finish.

L. Terminal Boards: 3/4 inch fire retardant fir plywood, painted two coats on both sides to match room finish and all edges, of size indicated on drawings; Maintain visibility of fire retardant stamp on each board. Anchor the board to the wall with bolts or screws and 1/4 inch washers.

PART 3 - EXECUTION

3.1 INSTALLATION OF CABLE SYSTEM

A. Site conditions: Contractor shall examine the areas and conditions under which the work of this section will be performed. Report unsatisfactory conditions to the Engineer before work begins.

B. Conduit subsystem

1. Excavation: Refer also to Section 260010.
   a. Notify the Owner at least 24 hours prior to excavation.
   b. Before excavation, contact the utilities for information on buried utilities and pipelines.

2. Conduits: Refer also to Sections 260110 and 260115.
a. Construct underground ductbanks of individual conduits supported by minus with plastic spacers. Ducts shall not be smaller than 4 inches in diameter unless otherwise specified. Provide mule tape in each conduit.

b. Provide plastic duct spacers between ducts, at a maximum 5 feet on center.

c. The top of the conduit shall not be less than 30 inches below grade.

d. Ductbanks shall have a continuous slope downward toward ground vaults and away from buildings with a pitch of not less than 4 inches in 100 feet. Except at conduit risers, accomplish changes in direction of runs exceeding a total of 10 degrees, either vertical or horizontal, by long sweep bends having a minimum radius of curvature of 25 feet. Manufactured bends shall have a minimum radius of 36 inches for ducts of 3 inches in diameter and larger.

e. Stagger joints of the conduit by rows and layers so as to provide a duct line having maximum strength. During construction, protect partially completed duct lines from the entrance of debris such as mud, sand, and dirt by means of suitable conduit plugs. As each section of a duct line is completed from ground vault to ground vault, draw a stiff bristle brush of the proper diameter through each duct until the conduit is clear of particles of earth, sand, and gravel; then immediately re-install conduit plugs.

f. Conduits may be installed to exterior and interior portions of a building to extend conduit from ground vaults to the building MDF or IDF. Install in the shortest path and comply with BISCI standards. Conduit shall be EMT or rigid metal conduit depending upon conditions and exposure to elements. EMT may only be installed in concealed spaces unless specifically approved by the Engineer.

g. Interior, in-wall, conduits for multiple cables to communication outlets are to be a minimum of 1 inch and dedicated conduits shall serve outlet boxes.

h. Empty conduits shall be installed with pull string and insulated bushing for future installations.

i. Interior conduit runs without pull boxes shall not exceed 100 feet in length and shall not contain more than 2 bends of 90 degrees each. Exterior and underground conduit runs shall not exceed 200 feet and shall not contain more than two 90 degree bends between pullboxes or vaults. If more than 2 bends of 90 degrees are required, the conduit run shall be increased by one trade size. Distances of up to 600 feet between underground pull boxes may be allowed if the conduit run between pull boxes has no bends, and is indicated on drawings.

j. Interior pull boxes shall be accessible. Pull boxes shall not be installed above hard lid ceilings, HVAC ducts, or mechanical piping. Pull boxes shall not be installed in place of bends.

k. Conduit types shall be limited to rigid metal conduit, electrical metallic tubing (EMT), and Schedule 40 PVC, as permitted under Section 260110.
## DATA EQUIPMENT AND WIRING SYSTEMS

**l.** Conduit shall be sized in accordance with Table 4.4-1, EIA/TIA-569 except as noted herein.

**m.** Conduit shall be reamed to eliminate sharp edges and terminated with an insulated bushing.

**n.** UL-approved fire-stop compound applicable to installation shall be used when penetrating fire-rated walls and floors.

**o.** Refer to Attachment A at the end of this section for additional specifications for conduit sizing. Conduit fill shall not exceed 40%.

### 3. Ground Vaults and Pull Boxes

**a.** Ground vaults and pull boxes shall be installed in paved areas with each box a minimum of one foot clear to edge of paving. The top of boxes shall be installed at the same elevation of finish surface of paving, or 2 inches above finished grade if installed in earth. Install boxes where runoff water will not drain to or into the box.

**b.** Provide pulling irons on opposite walls and below horizontal centerlines of ducts and cemented openings, and in bottom. Install pulling irons with each end hooked around a reinforcing bar.

**c.** Install a floor drain into a sump containing 2 cubic yards of crushed rock, minimum size 48 inches deep, and 36 inches diameter. Provide a 36-inch length of 6-inch diameter tile pipe extending down into sump and fill with gravel. Cover sump with grille.

**d.** Install a ground rod in each concrete pull box. Locate near a wall with a 6 inch projection above finished grade for installation of grounding clamps. Permanently bond and ground metal equipment cases, cable racks, and other metal objects in pull boxes. Grounding conductors shall be #6 gage bare stranded copper.

**e.** Cable splicing is not permitted.

### 4. Data Cable Termination Installation

**a.** Patch panels shall be installed in 24 or 48 port compliments. Contractor shall provide and install all necessary patch cords, both copper and fiber optic, for internal cabinet interconnections.

**b.** One EIA rack unit of horizontal wire management shall be provided adjacent to each patch panel.

**c.** Cables shall be dressed and terminated in accordance with TIA/EIA-568, manufacturer recommendations, and this specification.

**d.** Bend radius of the cable in the termination area shall not be less than 4 times the outside diameter of the cable.
e. Cables shall be neatly bundled, not overly tight, and dressed to their respective panels or blocks.

f. The cable jacket shall be maintained as close as possible to the termination point. Pair untwist shall be limited to ½”.

g. Patch cords installed in racks or cabinets shall be complimentary to horizontal cabling.

h. Contractor shall terminate both ends of cable, unless noted otherwise.

5. MDF / IDF Fiber Termination Hardware Installation

a. Fiber slack shall be neatly coiled within the fiber termination panel. No slack loops shall be allowed external to the fiber panels.

b. All cables shall be individually attached to the respective termination panels by mechanical means.

c. Each fiber cable shall be stripped upon entering termination panels and the individual fibers routed neatly into termination panels.

d. Dust caps shall be installed on unused connectors and couplings.

6. Racks/Cabinets

a. Racks and cabinets shall be floor- or wall-mounted, as required, and provided with tip bars and additional accessories as required for a complete functional system. Racks and cabinets shall be seismically braced and attached to horizontal ladder racking or cable tray with 3/4 inch threaded rod. Calculations shall be based on the maximum load rating of the cabinet by the manufacturer in a Zone 3 seismic environment, not the weight at time of occupancy.

b. There shall be enough space in the front and rear of MDF/IDF cabinets to accommodate 31-inch aisles.

c. Bond together cable grounds to distribution rack, and bond rack to building electrical panel ground for grounding continuity. Continuity shall be checked with an ohmmeter between adjacent components. Submit written certification to the Owner that the tested ohmmeter readings do not exceed one ohm. Equipment racks shall be grounded to building ground in accordance with EIA/TIA 607.

d. Provide keys and locks for cabinets and equipment.

7. Backbone Cabling

a. Proper bending radius and pulling strength requirements of cables shall be followed during handling and installation. Cables, splice cases, punch-down frames, patch panels and supporting hardware shall be installed in accordance with manufacturer recommendations.
b. Outside plant fiber shall be installed in 1-1/2 inch or one inch corrugated inner duct installed within the backbone conduit.

c. Interior innerduct and cable shall be plenum or riser rated, as required by applicable code regulation or standard. Riser rated innerduct as a minimum shall be installed on floor-to-floor fiber optic cabling.

d. Interior fiber shall be installed in conduit or raceway unless installed in the cable tray system where corrugated innerduct shall be used. Innerduct runs without conduit shall be installed properly strapped and supported every 4 feet. Innerduct shall be rated for indoor or outdoor use as applicable.

e. Cables in panels, cabinets, trays, and rack shall be neatly grouped and strapped using tie-wrap cable straps. Cables and panels shall be clearly identified at both ends with a unique cable numbering system and in compliance with TIA 606.

f. All fiber optic strands shall be terminated.

g. Refer to Part 1, System Description and plans for backbone cabling requirements.

8. Horizontal Cabling

a. Horizontal distribution cable for data circuits from an MDF or IDF to data outlets shall be Cat 6, 4-pair unshielded twisted pair, CMP or CMR rated as required. Quantities of cables to each outlet shall be in accordance with the plans.

1) Cable shall be installed in accordance with manufacturer recommendations.

2) Cable raceways shall not be filled greater than NEC maximum fill for the particular raceway type, normally 40%.

3) Cables shall be installed in continuous lengths from origin to destination.

4) Minimum bend radius and maximum pulling tension shall not be exceeded.

5) If a J-hook or trapeze system is indicated on the drawings, support horizontal cable bundles installed above ceilings at a maximum of 5 foot intervals. A minimum of 6 inches of clearance between ceiling grid and cable bundle shall be maintained. Cables shall not rest on acoustic ceiling grids or tiles. J-hooks and trapeze systems shall be installed only where indicated on the drawings.

6) Cable shall be installed above mechanical ducting and water lines and shall not be attached to other systems, equipment or hardware.

7) Cables shall not be attached to ceiling grid or lighting fixture support wires.

8) Cable that is damaged or subjected to installation practices outside of those specified within this document shall be replaced by the Contractor at no charge to Owner.
9) Unshielded twisted pair cable shall be installed so that there are no bends less than 4 times the cable outside diameter.

10) Pulling tension on 4-pair UTP cables shall not exceed 25 pounds for a single cable or bundled cable.

9. Labeling and Marking
   a. Provide complete cable location chart and as-built documentation in an envelope and attach to the rack/cabinet.
   b. Mark distribution panels, cables and coverplates with computer-generated labels. Drops shall be labeled with the same identifier on the receptacle faceplate, inside the junction box, on the cable at the jack, on the cable at the patch panel, on the termination side of the patch panel, and on the patch side of the patch panel. Cable markers shall be located within 2 inches of the end of the cable jacket and shall be directly readable. Panel labels shall be computer-generated and printed using a laser printer. A disk with the label files shall be submitted as part of the project record documents.
   c. Cable Identification Methodology: Utilize the room numbers of the facility to identify individual drops for new and existing facilities. Room number shall be comprised of the first three digits of the numbering scheme. In large facilities requiring more than three digits or in facilities with alpha-numeric room identifiers, adjust the numbering scheme accordingly. Backbone identifiers at the MDF shall indicate the IDF that it feeds. Identifiers shall be unique and in compliance with TIA 606.

3.2 CERTIFICATION AND TEST OF CABLEING SYSTEM

A. Cables and termination hardware shall be 100 percent tested for defects in installation and to verify cable performance under installed conditions. Conductors of installed cables shall be verified. Defect in the cabling system installation including, but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100 percent effectiveness.

B. Copper
   1. Cables shall be tested for continuity on pairs and/or conductors.
   2. Data cables shall be performance verified using an automated test set.
   3. This test set shall be certified level Ile. Provide the Owner with copies of factory calibration certificated for each test set. To ensure verifiable equipment calibration, the Owner may require field calibration each time a new set of tests are performed. Tester shall be capable of testing for the continuity parameters defined above, and provide results for the following tests:
      a. Attenuation
      b. Ambient noise.
      c. Attenuation to cross-talk ration (ACR).
d. Pair-to-pair near-end cross-talk (NEXT) loss (new limits).
e. Power sum near-end cross-talk (PSNEXT) loss.
f. Return loss.
g. Far-end cross-talk (FEXT).
h. Pair-to-pair equal level far-end cross-talk (ELFNEXT).
i. Power sum equal level cross-talk (PSELFEXT).
j. Propagation delay.
k. Delay skew.
l. Cable length verification.
m. Wire map.

4. Test results shall be automatically evaluated by equipment, using the most up-to-date criteria from the ANSI/TIA/EIA-568 standards and addendums.

5. Test results shall be printed directly from the test unit in native format, and both hard and soft copies in native format shall be provided to the Owner. The printed test results shall include tests performed, the expected test result, and the actual test result.

3.3 PROJECT RECORD DOCUMENTS

A. In addition to requirements specified in other sections, submit the following project record documents to the Engineer.

1. As-built drawings indicating equipment locations, wiring types, panel configurations, sizes and a point-to-point-wiring diagram of all circuits. Drawings shall indicate interfaces to equipment furnished by others, identifying numbers of wires, termination requirements, and other pertinent details.

2. Test results: Submit test results to the Engineer.

3.4 PROTECTION

A. Protect the work of this section until substantial completion.

3.5 CLEANUP

A. Remove rubbish, debris, and waste materials and legally dispose of off the project site.
# CONDUIT CAPACITY CHART

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<th>Trade Size in.</th>
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<td>6.1 (0.24)</td>
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<td>7.9 (0.31)</td>
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<td>9.4 (0.37)</td>
<td>13.5 (0.53)</td>
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<td>90</td>
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# CONDUIT PULL BOX CHART

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<th>Maximum Trade Size of Conduit</th>
<th>Size of Box</th>
<th>For each Additional Conduit Increase Width by:</th>
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<tr>
<td>Width</td>
<td>Length</td>
<td>Depth</td>
</tr>
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<td>21 mm (3/4 in.)</td>
<td>100 mm (4 in.)</td>
<td>300 mm (12 in.)</td>
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<td>27 mm (1 in.)</td>
<td>100 mm (4 in.)</td>
<td>400 mm (16 in.)</td>
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<tr>
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<td>150 mm (6 in.)</td>
<td>500 mm (20 in.)</td>
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<td>41 mm (1-1/2 in.)</td>
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<td>675 mm (27 in.)</td>
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<td>200 mm (8 in.)</td>
<td>900 mm (36 in.)</td>
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<td>300 mm (12 in.)</td>
<td>1350 mm (54 in.)</td>
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<td>103 mm (4 in.)</td>
<td>375 mm (15 in.)</td>
<td>1520 mm (60 in.)</td>
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END OF SECTION 260762
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SECTION 26 07 70 – LOW VOLTAGE SYSTEM ROUGH-IN

PART 1 - GENERAL

1.1 SUMMARY

A. This section covers complete rough-in for dispatch alerting and access control security equipment.

B. The security equipment shall be provided by the owner’s security system supplier.

C. The dispatch alerting equipment shall be provided by the owner’s alert system supplier.

D. Devices shown on drawings are for reference only. Exact number of devices, types and locations are determined from security contractor’s shop drawings. Provide complete conduit system.

E. Security system wires shall be furnished and installed by the security equipment supplier.

F. Alert system wires shall be furnished and installed by the alert system equipment supplier.

PART 2 - PRODUCTS

2.1 Provide conduit and boxes, as specified in Section 260110 or as shown on drawings.

PART 3 - EXECUTION

3.1 Provide raceways and boxes as shown on the drawings. This shall include two-gang boxes with single-gang raised cover and 1 inch empty conduit with insulated bushing roughed into an accessible ceiling.

3.2 All empty conduits shall be provided with a pull wire and insulated bushing.

3.3 Refer to rough-in details on project plans for access control and security rough-in boxes and conduits.

END OF SECTION 260770
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SECTION 26 09 38 – OCCUPANCY SENSORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.
   B. Section 260000 - Basic Electrical Requirements.
   C. Section 260010 - Basic Electrical Materials and Methods.
   D. Section 260500 - Interior Lighting.

1.2 WORK INCLUDED
   A. Occupancy sensors.

1.3 QUALITY ASSURANCE
   A. Units, and all accessories, shall be listed by Underwriter's Laboratories, Inc. and bear the appropriate UL label.

1.4 SUBMITTALS
   A. Submit shop drawings and product data under provisions of Section 260000.
   B. Submit shop drawings, product data, manufacturer’s installation instructions and operation and maintenance data for manufactured products and assemblies required for this project.
   C. Indicate electrical power connections on shop drawings or product data.
   D. Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.

PART 2 - PRODUCTS

2.1 OCCUPANCY SENSORS
   A. Manufacturer and model number given are intended to establish desired type, quality and performance. Equivalent products of the following manufacturers are equally acceptable:
      1. Sensor Switch
      2. Watt Stopper
      3. Leviton
   B. Occupancy sensors shall be equivalent to the following Sensor Switch types:

<table>
<thead>
<tr>
<th>Type</th>
<th>Model</th>
<th>Mounting</th>
<th>Tech.</th>
<th>Voltage</th>
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</tbody>
</table>
C. Provide all necessary sensors, boxes, conduits, power packs, control units, shields/ masks, etc., for a complete working system.

2.2 APPLICATION

A. All light fixtures controlled by occupancy sensors shall have programmed start type ballast to maintain lamp life.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install devices and assemblies plumb and secure.

B. Install on wall when ceiling is complete.

C. Location shall be checked for items that would conflict with beam spread. Provide masking as per manufacturer specifications and recommendations along glass walls to prevent nuisance activation.

D. Occupancy sensor power packs shall be located above accessible ceiling or in drywall ceiling conditions occupancy sensor power packs shall be installed in local storage rooms or janitors closets.

E. Maintain at least 4' from air devices (or more as specified by manufacturer.)

F. All line voltage devices shall have a neutral pulled to the device.

3.2 WIRING INSTALLATION

A. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
B. Size conductors according to control device manufacturer's written instructions, unless otherwise indicated.

C. 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 260010.

B. Identify controlled circuits in lighting control units.

C. Identify circuits or luminaries controlled by occupancy sensors at each sensor.

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.

2. Operational Test: Verify operation of each lighting control device, and adjust time delays, sensitivity, light levels, etc.

B. Control devices that fail tests and inspections are defective work.

3.5 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements in other Division 26 Sections.

END OF SECTION 260938
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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. Protecting existing vegetation to remain.
2. Removing existing vegetation as needed.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing site utilities.
7. Temporary erosion- and sedimentation-control measures.

1.3 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.4 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, parking lots, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises as directed by Owner or General Contractor.

C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

D. Do not commence site clearing operations until temporary erosion- and sedimentation control and plant protection measures are in place.

E. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 31 20 00 "Earth Moving."
   1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.
B. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated.
C. Protect existing site improvements to remain from damage during construction.
   1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. 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 erosion and sedimentation control drawings and requirements of authorities having jurisdiction.
B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
C. Inspect, maintain, and repair erosion and sedimentation control measures during construction until permanent vegetation has been established.
D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
3.3  TREE AND PLANT PROTECTION

A. General: Protect trees and plants remaining on-site according to requirements in Section 01 56 39 "Temporary Tree and Plant Protection."

B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Architect.

3.4  EXISTING UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.
   1. Arrange with utility companies to shut off indicated utilities.

B. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
   1. Notify Architect not less than two days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Architect's written permission.

C. Removal of underground utilities is included in earthwork sections and with applicable fire suppression, plumbing, HVAC, electrical, communications, electronic safety and security and utilities sections and Section 02 41 16 "Structure Demolition."

3.5  CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
   2. Use only hand methods for grubbing within protection zones.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
   1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer as directed in the soils report.

3.6  TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.
   1. Strip topsoil in a manner to prevent intermingling with underlying subsoil or other waste materials as directed in the soils report.
B. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

3.7 SITE IMPROVEMENTS

A. Remove existing above and below grade improvements as indicated and necessary to facilitate new construction.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

B. 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. Do not interfere with other Project work.

END OF SECTION 31 10 00
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. Preparing subgrades for slabs-on-grade, walks, pavements, turf and grasses and plants.
2. Excavating and backfilling for buildings and structures.
3. Drainage course for concrete slabs-on-grade.
4. Subbase course for concrete walks and pavements.
5. Subbase course and base course for asphalt paving.

1.3 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.
G. Fill: Soil materials used to raise existing grades.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

I. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 QUALITY ASSURANCE

A. Pre-excavation Conference: Conduct conference at location as determined by the General Contractor.

1.5 PROJECT CONDITIONS

A. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth moving operations.

B. Do not commence earth moving operations until plant-protection measures specified in Section 01 56 39 "Temporary Tree and Plant Protection" are in place.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification Groups CL, ML, CL-ML, GW, SW, SM and SC-SM according to ASTM D 2487 or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

1. Liquid Limit: 45
2. Plasticity Index: 25

C. Unsatisfactory Soils: Soil Classification Groups OL, OH, and PT according to ASTM D 2487, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1 inch sieve and not more than 6 percent passing a No. 200 sieve.

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

H. Drainage Course: Narrowly graded mixture of washed crushed stone or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

2.2 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored to comply with local practice or requirements of authorities having jurisdiction.

B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored to comply with local practice or requirements of authorities having jurisdiction.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may
include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.3 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

B. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

2. Cut and protect roots according to requirements in Section 01 56 39 "Temporary Tree and Plant Protection."

3.4 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.5 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: 12 inches each side of pipe or conduit.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material, 4 inches deeper elsewhere, to allow for bedding course.

D. Trenches in Tree- and Plant-Protection Zones:
1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
3. Cut and protect roots according to requirements in Section 01 56 39 "Temporary Tree and Plant Protection."

3.6 SUBGRADE INSPECTION

A. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired dump truck to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

B. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.7 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.8 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.9 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in "Cast-in-Place Concrete”.

D. Trenches under Roadways: Provide 4-inch thick, concrete-base slab support for piping or conduit less than 24 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling
or placing roadway subbase course. Concrete is specified in Section 03 30 00 "Cast-in-Place Concrete".

E. Place and compact initial backfill of subbase material, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.

   1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

F. Place and compact final backfill of satisfactory soil to final subgrade elevation.

G. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 5 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

   1. Under grass and planted areas, use satisfactory soil material.
   2. Under walks and pavements, use satisfactory soil material.
   3. Under steps and ramps, use engineered fill.
   4. Under building slabs, use engineered fill.
   5. Under footings and foundations, use engineered fill.

3.11 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

   1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
   2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.12 COMPACTATION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry density according to ASTM D 698:
1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 90 percent.
2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 90 percent.
3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 90 percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at 90 percent.

3.13 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
   1. Turf or Unpaved Areas: Plus or minus 1 inch.
   2. Walks: Plus or minus 1 inch.
   3. Pavements: Plus or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.14 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course and/or base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course and/or base course under pavements and walks as follows:
   1. Shape subbase course and/or base course to required crown elevations and cross-slope grades.
   2. Place subbase course and/or base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
   3. Compact subbase course and/or base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 90 percent of maximum dry density according to ASTM D 698.

3.15 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
   1. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
2. Compact each layer of drainage course to required cross sections and thicknesses to not less than 90 percent of maximum dry density according to ASTM D 698.

3.16 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

D. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.17 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.18 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 31 20 00
SECTION 31 31 16 - TERMITE CONTROL

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:

B. Related Requirements:
   1. Section 06 10 53 "Miscellaneous Rough Carpentry" for wood preservative treatment by pressure process.
   2. Section 07 62 00 "Sheet Metal Flashing and Trim" for custom-fabricated, metal termite shields.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components, and profiles for termite control products.
   2. Include the EPA-Registered Label for termiticide products.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Product Certificates: For each type of termite control product.

C. Research/Evaluation Reports: For metal mesh barrier system.
1.6 QUALITY ASSURANCE
   A. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located and who employs workers trained and approved by manufacturer to install manufacturer's products and who is accredited by manufacturer.

1.7 FIELD CONDITIONS
   A. Soil Treatment:
      1. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.
      2. Related Work: Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.

1.8 WARRANTY
   A. Soil Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work consisting of applied soil termiticide treatment will prevent infestation of subterranean termites, including Formosan termites (Coptotermes formosanus). If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.
      1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Source Limitations: Obtain termite control products from single source from single manufacturer.

2.2 SOIL TREATMENT
   A. Termiticide: EPA-Registered termiticide acceptable to authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation.
      1. Products: Subject to compliance with requirements, provide one of the following:
         a. BASF Corporation, Pest Control Solutions; Phantom Termidor.
         b. Bayer Environmental Science; Premise 2 Premise 75 Premise Pre-Construction Premise Pro.
c. Ensystex; Maxxthor SC Prothor SC2 Prothor WSP.
d. Syngenta; Demon Max.

2. Service Life of Treatment: Soil treatment termiticide that is effective for not less than five years against infestation of subterranean termites.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of soil per termiticide label, interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.

B. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. General: Prepare work areas according to the requirements of authorities having jurisdiction and according to manufacturer's written instructions before beginning application and installation of termite control treatment(s). Remove extraneous sources of wood cellulose and other edible materials, such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.

B. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated, except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termite control manufacturer.

1. Fit filling hose connected to water source at the site with a backflow preventer, according to requirements of authorities having jurisdiction.

3.3 APPLYING SOIL TREATMENT

A. Application: Mix soil treatment termiticide solution to a uniform consistency. Distribute treatment uniformly. Apply treatment at the product's EPA-Registered Label volume and rate for maximum specified concentration of termiticide to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction.

1. Slabs-on-Grade and Basement Slabs: Underground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
2. Foundations: Soil adjacent to and along the entire inside perimeter of foundation walls; along both sides of interior partition walls; around plumbing pipes and electric conduit penetrating the slab; around interior column footers, piers, and chimney bases; and along the entire outside perimeter, from grade to bottom of footing.


4. Penetrations: At expansion joints, control joints, and areas where slabs and below-grade walls will be penetrated.

B. Post warning signs in areas of application.

C. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

3.4 PROTECTION

A. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.

B. Protect termiticide solution dispersed in treated soils and fills from being diluted by exposure to water spillage or weather until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.

END OF SECTION 31 31 16
SECTION 31 50 00 - EXCAVATION SUPPORT AND PROTECTION

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 temporary excavation support and protection systems.

B. Related Requirements:
   1. Section 312000 "Earth Moving" for excavating and backfilling and for controlling surface-water runoff and ponding.
   2. Section 312319 "Dewatering" for dewatering excavations.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Review geotechnical report.
   2. Review existing utilities and subsurface conditions.
   3. Review coordination for interruption, shutoff, capping, and continuation of utility services.
   4. Review proposed excavations.
   5. Review proposed equipment.
   6. Review monitoring of excavation support and protection system.
   7. Review coordination with waterproofing.
   8. Review abandonment or removal of excavation support and protection system.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, performance properties, and dimensions of individual components and profiles, and calculations for excavation support and protection system.

B. Shop Drawings: For excavation support and protection system, prepared by or under the supervision of a qualified professional engineer.
   1. Include plans, elevations, sections, and details.
2. Show arrangement, locations, and details of soldier piles, piling, lagging, tiebacks, bracing, and other components of excavation support and protection system according to engineering design.

3. Indicate type and location of waterproofing.

4. Include a written plan for excavation support and protection, including sequence of construction of support and protection coordinated with progress of excavation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For land surveyor and professional engineer.

B. Contractor Calculations: For excavation support and protection system. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Existing Conditions: Using photographs, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by inadequate performance of excavation support and protection systems. Submit before Work begins.

D. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

1.6 FIELD CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

1. Notify Architect, Construction Manager, and Owner no fewer than two days in advance of proposed interruption of utility.
2. Do not proceed with interruption of utility without Owner's written permission.

B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from the data.

1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection according to the performance requirements.
2. The geotechnical report is included elsewhere in Project Manual.

C. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide, design, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting earth and hydrostatic pressures and superimposed and construction loads.

1. Contractor Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer.
2. Prevent surface water from entering excavations by grading, dikes, or other means.
3. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.
4. Continuously monitor vibrations, settlements, and movements to ensure stability of excavations and constructed slopes and to ensure that damage to permanent structures is prevented.

2.2 MATERIALS

A. General: Provide materials that are either new or in serviceable condition.

B. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.

C. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.

1. Corners: Site-fabricated mechanical interlock or Roll-formed corner shape with continuous interlock.

D. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.

E. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

F. Tiebacks: Steel bars, ASTM A 722/A 722M.

G. Tiebacks: Steel strand, ASTM A 416/A 416M.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

1. Shore, support, and protect utilities encountered.
B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Locate excavation support and protection systems clear of permanent construction so that construction and finishing of other work is not impeded.

3.2 SHEET PILING

   A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock vertical edges to form a continuous barrier.

   B. Accurately place the piling, using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer. Limit vertical offset of adjacent sheet piling to 60 inches (1500 mm). Accurately align exposed faces of sheet piling to vary not more than 2 inches (50 mm) from a horizontal line and not more than 1:120 out of vertical alignment.

   C. Cut tops of sheet piling to uniform elevation at top of excavation.

3.3 TIEBACKS

   A. Drill, install, grout, and tension tiebacks.

   B. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.

      1. Have test loading observed by a qualified professional engineer responsible for design of excavation support and protection system.

   C. Maintain tiebacks in place until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.4 BRACING

   A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.

      1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Architect.

      2. Install internal bracing if required to prevent spreading or distortion of braced frames.

      3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.
3.5 FIELD QUALITY CONTROL

A. Survey-Work Benchmarks: Resurvey benchmarks regularly during installation of excavation support and protection systems, excavation progress, and for as long as excavation remains open. Maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

B. Promptly correct detected bulges, breakage, or other evidence of movement to ensure that excavation support and protection system remains stable.

C. Promptly repair damages to adjacent facilities caused by installation or faulty performance of excavation support and protection systems.

3.6 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities.

1. Remove excavation support and protection systems to a minimum depth of 48 inches (1200 mm) below overlying construction and abandon remainder.
2. Fill voids immediately with approved backfill compacted to density specified in Section 312000 "Earth Moving."
3. Repair or replace, as approved by Architect, adjacent work damaged or displaced by removing excavation support and protection systems.

B. Leave excavation support and protection systems permanently in place.

END OF SECTION 315000
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1) GENERAL

1.1 SCOPE

A. Furnish labor, equipment, material and services necessary to provide and install the following:

(1) Drives and curbs.
(2) Parking areas.
(3) Sealer.
(4) Pavement markings.
(5) Precast parking curbs.

B. Related work specified elsewhere:

(1) Section 312316 - Excavating, Etc.
(2) Section 221113 - Site Water Service System.
(3) Section 334100 - Site Sewer Collection System.
(4) Section 321313 - Concrete and Cement Work.

1.2 SUBMITTALS

A. Materials List: Submit copies of lists identifying types and sources of materials proposed for this work.
B. Testing Laboratory Reports: Submit copies of laboratory test reports for asphaltic concrete materials, mixtures and in-place construction.
C. Material Certificates: Provide copies of materials certificates in lieu of materials laboratory test reports when permitted by the Architect. Material certificates shall be signed by material producer and Contractor, certifying that each material or item complies with, or exceeds, specified requirements.

1.3 DRAY TICKETS

A. Retain all dray tickets for rock and asphaltic concrete mixtures employed; submit to the Architect for verification upon request.

1.4 APPROVAL OF SUBGRADE

A. Inspect subgrade prior to beginning this work and notify if subgrade is not satisfactory; copy of such report shall be sent to the Architect. Commencing work shall be deemed as acceptance of responsibility for the condition of the subgrade.

1.5 JOB CONDITIONS

A. Weather Limitations: Apply bituminous prime and tack coats only when ambient temperature in shade is above 50° F and when temperature has not been below 35° F for 12 hours immediately prior to application. Do not apply when base surface is wet or contains an excess of moisture which would prevent uniform distribution and required penetration.
B. Construct asphaltic concrete surface course when atmospheric temperature is above 40°F, when underlying base is dry, and when weather is not rainy.
C. No work shall be performed on frozen or wet subgrade earth or rock base.
D. Grade Control: Establish and maintain required lines and grades, including crown and cross slopes, for each course during construction operations.
   (1) Contractor shall be responsible for coordinating correct elevations of inlets, catch basins, manhole covers, and all recessed items within pavement surfaces. Contractor shall notify the General Contractor and Architect of any item installed by other trades which are unacceptable to meet the required elevation for proper finish pavement elevation installation.
   (2) Contractor shall review with the Architect or Engineer prior to starting work, any finished pavement elevation which will not provide for proper or adequate pavement slope to facilitate surface water drainage.
E. Traffic Control
   (1) Provide flagmen, barricades, warning signs, warning lights, etc., for traffic control, movement, and safety and to cause the least interruption of the work and public right-of-way where required.
   (2) Maintain vehicular and pedestrian traffic during paving operations, as required for other construction activities.
   (3) Protection: Paving shall be barricaded so that it will not be used for at least 36 hours after placement. Remove barricades at proper time.

1.6 SAMPLING AND TESTING
A. If requested by the Architect and/or Engineer, the Contractor shall furnish representative samples of the materials to be used in the work, both prior to use and assist in core sampling if requested.
B. Sampling and testing shall be in accordance with the latest revisions of the American Association of State Highway and Transportation Officials (AASHTO) and/or the American Society for Testing and Materials (ASTM) standard procedures for sampling and testing the materials being used in the project.
C. Tests performed shall be determined by the Architect and/or Engineer, and shall be performed by a testing laboratory approved by the Architect and/or Engineer. The Owner shall bear all costs for sampling and testing without limitation.
D. Core sampling will only be performed when the pavement thickness is in question. If core sampling indicates a deficiency in thickness, the Contractor will be responsible for paying for core sample testing and correcting of the deficiency.

1.7 GUARANTEE
A. The Contractor shall guarantee all pavement and related work, including materials and workmanship, for a period of one (1) year from the date of Substantial Completion or acceptance of this pavement work, if it occurs after Substantial Completion.
B. The Contractor shall replace all defective materials without limitation, under normal use, and shall make interim repairs as necessary to maintain all paved areas in good, usable condition. The Contractor shall receive no additional compensation for pavement maintenance and restoration.
1.8 QUALITY ASSURANCE

A. All construction and materials shall comply with Jefferson County standard specifications for Highway Construction, latest edition.

2) PRODUCTS

2.1 MATERIALS

A. Rock Base: Crushed stone aggregate and screenings shall conform to the following:

(1) Percentage of wear shall be not greater than 50 when tested according to ASTM Specification C-131.

(2) Soundness shall conform to ASTM Specification C-88.

(3) Crushed rock shall be 1” minus and shall consist of sound, durable particles of limestone or dolomite, and shall not contain deleterious material.

B. Plant Mix Asphaltic Concrete

(1) Mineral Aggregate (Asphalt Plant Mix Base and Surface)

(a) The mineral aggregate for asphalt plant mix shall consist of coarse aggregate, fine aggregate, and, if needed, mineral filler. The coarse aggregate shall be sound, angular crushed stone or crushed gravel. The fine aggregate shall be a well-graded sand.

(b) Mineral filler shall consist of limestone dust, Portland cement or other suitable mineral matter.

(c) The mineral aggregate and asphalt shall be combined to meet the following gradations for asphalt plant mix base and surface.

<table>
<thead>
<tr>
<th>Surface Mixture Sieve Size</th>
<th>Percent Passing by Weight</th>
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<tr>
<td>¾ in</td>
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<td>#200</td>
<td>2-7</td>
</tr>
<tr>
<td>Asphalt</td>
<td>4-7</td>
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</table>

(Percent by Weight of total mix)
(2) Asphalt Materials (Asphalt Plant Mix Base and Surface)

(a) Asphaltic materials shall conform to the latest ASTM, AASHTO or Jefferson County specifications for penetration and viscosity grade asphalt cement.

(b) Surface wearing course shall be in conformance with the Jefferson County, Type C.

(c) Job Mix Formula: Submit mix formula for each asphalt-aggregate mixture complying with specifications for review prior to installation.

(d) All mixtures shall be mixed in an asphalt plant which has been approved by the Engineer, and shall arrive on the job site at not less than 240 degrees F.

C. **Prime Coat**: Type MC-30 or RC-70.

D. **Tack Coat**: Liquid asphalt type RC-70, MC-30 or MC-70.

E. **Surface Sealer**: Protective pavement sealer shall be a two (2) coat system of coal-tar pitch and sand slurry system. System shall be McConnell & Associates Corporation MAC-52 protective surface treatment conforming to manufacturer's MAC-S2 two coat sand slurry system. Comparable products by Neyra Industries, Inc. are also acceptable.

F. **Herbicide Treatment**: Commercial chemical for weed control, registered by Environmental Protection Agency (EPA). Provide in granular, liquid or wettable powder form. Herbicide manufacturer by Allied Chemical Corp., Dow Chemical, DuPont or comparable shall be acceptable. Herbicide shall be of appropriate type as recommended by manufacturer.

G. **Pavement Marking Paint**: Water based acrylic paint as manufactured by McConnell & Assoc. Corp., or Pratt and Lambert Alkyd Flat, shall be acceptable for striping and markings.

H. **Precast Parking Curb**: Furnish and install precast concrete parking curb comparable to "Bennett Heavy Duty Parking Curb", 9"W x 7'-0"L x 6"H, reinforced with four #3 bars, and complete with 7/8" x 24" anchor pins. Design of curb shall permit drainage under curb.

I. **Water**: Potable and free of injurious amounts of alkali, acids, salts, and organic impurities.

3) EXECUTION

3.1 GENERAL

A. Layout all paving areas as indicated on the drawings and as required to complete the work.

B. All paving shall be finished to thickness, grades, and elevations as indicated on site plan and graded to meet all adjacent paving as required.

C. Finished surfaces shall be sloped as required for complete and proper drainage,
and shall be free of local depressions as evidenced by "puddles" apparent one hour after a rain, or after thorough hosing of completed paving.

D. Testing of finished surface for smoothness shall also be within the following tolerances for smoothness using a 10 ft. straight-edge applied parallel with and at right angles to center line or water flow of paved area. Surfaces will not be acceptable if exceeding the following tolerances:

(1) Wearing surface - ¼" (+/-).

E. Adjacent surfaces and structures shall be adequately protected from spillage or other damage due to paving work.

F. Material shall not be dumped in load piles or rehandled to extent where uniformity of mixture is disturbed.

G. Edges shall be left neat and straight.

H. All debris, tools, equipment, and surplus materials shall be removed from the premises immediately upon completion of paving.

I. All joints to be sealed and caulked.

3.2 SMOOTHNESS

i) Finished DRIVEWAY AND SIDEWALK SURFACES shall be within the following tolerances for smoothness using a 10 ft. straight-edge applied parallel with and at right angles to center line or the water flow of paved area: Wearing surface: 1/4" (+/-).

3.3 SUBGRADE PREPARATION

A. Blade or hand grade all subgrade surfaces as required to provide adequate surface, properly sloped for drainage, and in conformance with required elevations.

B. Prior to the start of paving operations, the subgrade surface shall be prepared by filling in wheel ruts, erosions and all other ground disturbances regardless of cause, and the ground surface shall be fine graded so that after proof-rolling the subgrade surface will be at the proper level to receive the pavement.

C. All subgrade earth shall be proof-rolled by means of a roller weighing not less than ten tons or other compaction equipment satisfactory to the Architect and/or Engineer.

D. If any localized soft spot(s) smaller than 1,000 square feet of soil is identified, the soft spot shall be removed and replaced with aggregate as directed by the Architect and/or Engineer at no additional cost.

E. Any additional unsatisfactory sub-grade soil conditions which are not suitable for the pavement structure shall be reviewed with the Architect or Engineer, who may order corrective undercut and backfill work done after review/approval by the Owner.

F. No paving operations shall commence until finished subgrade elevations and backfill and compaction operations have been completed adjacent to all curbs, catch basins, gutters, manholes and/or any appurtenances or utility structures.
within the area to be paved.

G. The Architect or Engineer must approve the subgrade prior to placement of the rock base course. Installation of all or any portion of the base course without subgrade approval by the Architect or Engineer is done at the Contractor's risk.

H. Approval of the subgrade by the Architect or Engineer shall not relieve the Contractor of his responsibility to protect the subgrade from damage caused from excessive moisture, rutting from trucks or heavy equipment, or from any other cause, and any damage occurring to the subgrade either before, or during, the paving operations shall be corrected to the satisfaction of the Architect or Engineer, at the Contractor's expense.

3.4 PREPARATION FOR PAVEMENT INSTALLATION

A. Utility Structures and Appurtenances

(1) After the subgrade surface has been prepared as specified herein, the Contractor shall check all frames, covers, grates, water valve boxes and all other miscellaneous castings that are located in the proposed pavement areas to ensure that all such items have been accurately positioned and set to the proper slope and elevation. All covers and grates are to be set flush with the required finish pavement surface. No depressions or mounds will be permitted in the pavement to accommodate inaccuracies in the setting of these appurtenances. All corrective work as may be necessary shall be done at the Contractor's expense.

B. Meeting Existing Pavements

(1) Where new pavements are to meet existing pavements, the Contractor shall saw cut the existing pavements with mechanical cutting tools so that there will be a vertical butting surface between the old and new pavements. Line cutting of existing pavements shall be along neat, straight and even lines, and shall be done in such a manner so as not to damage the adjacent pavement which is to remain.

(a) Any cutting and replacement of pavement and base within a public right-of-way shall conform to all requirements of the public jurisdiction having authority of the right-of-way, without limitation and/or additional cost to the Owner.

C. Soil Sterilization

(1) Prior to paving operations, all paved areas shall be sterilized by application of granular or liquid herbicide treatment.

(2) Soil sterilization shall be placed immediately prior to placement of the rock base.

(3) Treatment shall be installed in strict conformance with manufacturer's in-
3.5 APPLICATION OF BASE COURSE (ROCK)

A. The placement of the rock base course, when completed, shall meet the specified thicknesses as outlined in the scope of work and indicated on the drawings. The following general placement guidelines shall be followed:

1. Light Duty Pavement - Total rock base thickness of 8" shall be placed in lifts not to exceed 4".
2. Heavy Duty Pavement - Total rock base thickness of 12" shall be placed in lifts not to exceed 6".

B. Application of Individual Layers of Each Lift (See Compaction Section)

1. First Layer
   a. Spread rock at the specified thickness.
   b. Blade to uniform plane.
   c. Compact with power-driven roller.

2. Second Layer
   a. Repeat above operations of placing course stone and screenings.

3. Hauling over uncompacted base course layers shall not be permitted.
4. Completed Rock Base
   a. Contractor shall be responsible for providing and installing erosion control materials, including hay bales, fabric screens, etc. as required to prevent adjacent soil from eroding onto rock base course. Any soil which has covered the completed rock base shall be removed, and new clean rock base shall be installed without additional cost to the Owner.

3.6 PREPARATION OF ROCK BASE FOR ASPHALTIC CONCRETE PAVING

A. Contractor shall examine all areas and conditions under which asphaltic concrete paving is to be installed and notify the General Contractor, Architect and/or Engineer in writing of conditions detrimental to the proper completion and timely completion of the specified asphaltic paving work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Architect and/or Engineer.

B. If subgrade material has worked to the surface, or if any movement is found in the rock base, the Contractor shall remove the soft spot and install new aggregate base at no additional cost to the Owner.
C. Remove any soil or loose material which has covered the installed asphaltic concrete base (if applicable) prior to installing finishing wearing course.

D. Prime Coat
   (1) Uniformly apply prime coat, distributed at rate of 0.20 to 0.50 gallons per square yard, over compacted base course surface.
   (2) Apply sufficient material to penetrate and seal, but not flood, the surface.
   (3) Allow to cure and dry as long as required to attain penetration and evaporation of volatile, and in no case less than 48 hours.

E. Tack Coat
   (1) Apply to contact surfaces of previously constructed bituminous concrete or Portland cement concrete and similar surfaces.
   (2) Distribute at the rate of 0.05 to 0.15 gallon per square yard of surface.
   (3) Apply tack coat by brush to contact surfaces of curbs, gutters, manholes, and other structures projecting into or abutting asphaltic concrete pavement.
   (4) Allow surfaces to dry until tack coat material is at proper condition of tackiness to receive asphalt concrete mixture.

3.7 ASPHALTIC CONCRETE PLACEMENT

A. General
   (1) All asphaltic concrete shall be mixed in an asphalt plant which has submitted an approved mix design.
   (2) All asphaltic concrete shall be delivered to the site at not less than 240°F.
   (3) Acceptable completed compacted wearing surface thickness shall be within one-quarter inch (¼”) +/- of the specified thickness.

B. Specified Base and Wearing Surface Thicknesses
   (1) Place asphaltic concrete mixture on prepared surface and strike-off using an acceptable bituminous paver in lifts as required to meet the specified thickness as follows:
      
      (a) Light Duty Pavement - Total compacted thickness 3”, in two – 1 1/2" thick lifts.
      (b) Heavy Duty Pavement - Total compacted thickness of 4”, in two - 2” thick lifts.

C. Spreading and Placing Asphaltic Concrete
   (1) Paver Placing:
(a) Unless otherwise directed, begin placing along center line of areas to be paved on a crowned section, and at the high side of sections with a one-way slope, and in direction of traffic flow.

(b) Place in strips not less than 10' wide, unless otherwise acceptable to the Engineer. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete base course for a section before placing surface course materials. Place mixture in as continuous an operation as possible.

(2) Hand Placing:

(a) Spread, tamp and finish mixture using hand tools in areas where use of machine spreading is not practical. Place mixture at a rate that will ensure proper handling and compaction before mixture becomes cooler than acceptable working temperature.

(3) Joints:

(a) Carefully make joints between old and new pavements, or between successive days' work, to ensure continuous bond between adjoining work. Construct joints to have same texture, density and smoothness as other sections of asphalt concrete course.

(b) Clean contact surfaces of sand, dirt, or other objectionable material and apply tack coat.

(4) Offset transverse joints in succeeding courses not less than 24". Cut back edge of previously placed course to expose even, vertical surface for full course thickness.

(5) Offset longitudinal joints in succeeding courses not less than 6". When edges of longitudinal joints are irregular, honeycombed, or inadequately compacted, cut back unsatisfactory sections to expose even, vertical surface for full course thickness.

(6) Protect newly placed material from traffic by barricades, or other suitable methods, until mixture has cooled and attained its maximum degree of hardness.

D. Compacting the Mix

(1) General:

(a) Begin rolling operations as soon as possible after placing, when mixture will bear weight of roller, without excessive displacement. Do not suddenly change line or direction of rolling.

(b) Compact mixture with hot hand tampers or vibrating plate compactors in areas inaccessible to rollers.
(c) Do not permit heavy equipment, including rollers, to stand on finished surface before it has thoroughly cooled or set.

(2) Procedure:

(a) Start rolling longitudinally at extreme lower side of sections and proceed toward center of pavement. Roll to slightly different lengths on alternate runs of rollers. Do not roll center of sections first under any circumstances.

(3) Breakdown Rolling:

(a) Accomplish breakdown or initial rolling immediately following rolling of transverse and longitudinal joints and outside edge. Operate rollers as close as possible to paver without causing displacement.
(b) Check crown, grade, and smoothness after breakdown rolling. Repair displaced areas by loosening at once with lutes or rakes and filling, if required, with hot loose material before continuing rolling.

(4) Second Rolling:

(a) Follow breakdown rolling as soon as possible, while mixture is hot, and in condition for proper compaction.
(b) Continue second rolling for at least three complete coverages, or until mixture has been thoroughly compacted.

(5) Finish Rolling:

(a) Perform finish rolling while mixture is still warm enough for removal of roller marks. Continue rolling until roller marks are eliminated, and the course has attained the required density.

(6) Patching:

(a) Remove and replace mixtures that become mixed with foreign materials and defective areas. Cut out such areas and fill with fresh, hot asphaltic concrete. Compact by rolling to required surface density and smoothness.
(b) Remove deficient areas for full depth of the course. Cut sides perpendicular and parallel to direction of traffic with edges vertical. Apply tack coat before placing asphalt concrete mixture.

3.8 ASPHALT CURBS
A. No asphalt curb is allowed. Apply a light tack coat unless pavement is still tacky and free from dust.

3.9 PAVEMENT SEALER

A. Sweep paving clean of all dust, dirt, and other foreign matter. Remove oil and fuel drippings by scrubbing with detergent and water and flush with clean water.
B. Apply two (2) coats of pavement sealer, as specified, to all new asphaltic concrete pavement and curbs.
C. Sealer shall be installed in strict accordance with manufacturer's specifications and instructions.

3.10 PAVEMENT TEST

A. Flood the surface with water immediately after the asphalt is capable of handling traffic, but within 24 hours. If, after 20 minutes of drying time, there are bird-baths evident, the Contractor and Architect, in conjunction with the surfacing contractor shall determine the method of correction. No cold tar patching, skin patching or sand mix patching will be acceptable.

3.11 PAVEMENT MARKINGS

A. Contractor shall provide and install pavement marking paint as specified.
B. Install all markings as shown on the drawings and/or as noted herein including:
   (1) Parking stall layout lines.
   (2) Handicapped symbol and stripping.
   (3) Traffic control directional arrows and miscellaneous markings.
   (4) Curb painting as indicated on the drawings.
C. Pavement marking shall be installed per manufacturer's specifications and instructions.

3.12 PRECAST CONCRETE PARKING CURB

A. Furnish and install precast parking curb bumpers as specified and as indicated on the drawings.
B. Units shall be anchored with 5/8" x 24" long anchor pins into pavement.
C. Provide one (1) curb per each parking stall where shown on the drawings.

3.13 CLEAN UP

A. Remove all excess material and debris from site.
B. Clean all surfaces of other materials. Any staining which cannot be removed shall
be replaced at the contractor's expense.
C. Remove equipment and barricades from site.

END OF SECTION 32 1216
SECTION 32 13 13 – CONCRETE PAVING

1. GENERAL

1.1 SCOPE

A. Furnish labor, equipment, material and services necessary to provide and install the following as noted on the drawings.

(1) Drives and curbs.
(2) Parking areas.
(3) Turnarounds.
(4) Pavement markings.

B. Related work specified elsewhere:

(1) Section 312316 - Excavating, Etc.
(2) Section 221113 - Site Water Service System.
(3) Section 334100 - Site Sewer Collection System.
(4) Section 321216 – Asphalt Paving.

1.2 SUBMITTALS

A. Materials List: Submit copies of lists identifying types and sources of materials proposed for this work.

B. Design Mixtures: For each concrete pavement mixture. Include alternate mixture designs when characteristics of materials, project conditions, weather, test results or other circumstances warrant adjustments.

C. Testing Laboratory Reports: Submit copies of laboratory test reports for asphaltic concrete materials, mixtures and in-place construction.

D. Material Certificates: Provide copies of materials certificates in lieu of materials laboratory test reports when permitted by the Architect. Material certificates shall be signed by material producer and Contractor, certifying that each material or item complies with, or exceeds, specified requirements. Material certificates shall be provided for:

1) Cementitious Material
2) Steel Reinforcement and reinforcement accessories
3) Admixtures
4) Curing compounds

1.3 APPROVAL OF SUBGRADE

A. Inspect subgrade prior to beginning this work and notify if subgrade is not satisfactory; copy of such report shall be sent to the Architect. Commencing work shall be deemed as acceptance of responsibility for the condition of the subgrade.

1.4 JOB CONDITIONS
A. No work shall be performed on frozen or wet subgrade earth or rock base.

B. Grade Control: Establish and maintain required lines and grades, including crown and cross slopes, for each course during construction operations.

   (1) Contractor shall be responsible for coordinating correct elevations of inlets, catch basins, manhole covers, and all recessed items within pavement surfaces. Contractor shall notify the General Contractor and Architect of any item installed by other trades which are unacceptable to meet the required elevation for proper finish pavement elevation installation.

   (2) Contractor shall review with the Architect or Engineer prior to starting work, any finished pavement elevation which will not provide for proper or adequate pavement slope to facilitate surface water drainage.

C. Traffic Control

   (1) Provide flagmen, barricades, warning signs, warning lights, etc., for traffic control, movement, and safety and to cause the least interruption of the work and public right-of-way where required.

   (2) Maintain vehicular and pedestrian traffic during paving operations, as required for other construction activities.

   (3) Protection: Paving shall be barricaded so that it will not be used for at least 36 hours after placement. Remove barricades at proper time.

1.5 SAMPLING AND TESTING

A. If requested by the Architect and/or Engineer, the Contractor shall furnish representative samples of the materials to be used in the work, both prior to use and assist in core sampling if requested.

B. Sampling and testing shall be in accordance with the latest revisions of the American Association of State Highway and Transportation Officials (AASHTO) and/or the American Society for Testing and Materials (ASTM) standard procedures for sampling and testing the materials being used in the project.

C. Tests performed shall be determined by the Architect and/or Engineer, and shall be performed by a testing laboratory approved by the Architect and/or Engineer. The Owner shall bear all costs for sampling and testing without limitation.

D. Core sampling will only be performed when the pavement thickness is in question. If core sampling indicates a deficiency in thickness, the Contractor will be responsible for paying for core sample testing and correcting of the deficiency.

1.6 GUARANTEE

A. The Contractor shall guarantee all pavement and related work, including materials and workmanship, for a period of one (1) year from the date of Substantial Completion or acceptance of this pavement work, if it occurs after Substantial Completion.

B. The Contractor shall replace all defective materials without limitation, under normal use, and shall make interim repairs as necessary to maintain all paved areas in good, usable condition. The Contractor shall receive no additional compensation for pavement maintenance and restoration.

1.7 QUALITY ASSURANCE

2. PRODUCTS

2.1 MATERIALS

A. Concrete Pavement shall meet the requirements of ASTM C-150 and be prepared in accordance with this section of the specifications.
B. Pavement Marking Paint: Water based acrylic paint as manufactured by McConnell & Assoc. Corp., or Pratt and Lambert Alkyd Flat, shall be acceptable for striping and markings.
C. Water: Potable and free of injurious amounts of alkali, acids, salts, and organic impurities.

3. EXECUTION

3.1 GENERAL

A. Layout all paving areas as indicated on the drawings and as required to complete the work.
B. All paving shall be finished to thickness, grades, and elevations as indicated on site plan and graded to meet all adjacent paving as required.
C. Finished surfaces shall be sloped as required for complete and proper drainage, and shall be free of local depressions as evidenced by "puddles" apparent one hour after a rain, or after thorough hosing of completed paving.
D. Testing of finished surface for smoothness shall also be within the following tolerances for smoothness using a 10 ft. straight-edge applied parallel with and at right angles to center line or water flow of paved area. Surfaces will not be acceptable if exceeding the following tolerances:

(1) Wearing surface - ¼" (+/-).
E. Adjacent surfaces and structures shall be adequately protected from spillage or other damage due to paving work.
F. Material shall not be dumped in load piles or rehandled to extent where uniformity of mixture is disturbed.
G. Edges shall be left neat and straight.
H. All debris, tools, equipment, and surplus materials shall be removed from the premises immediately upon completion of paving.
I. Provide all rebar at expansion and control joints.
J. All joints to be caulked.

3.2 SUBGRADE PREPARATION

A. Soil treatment to sub-grade as shown on the drawings and as described in Specification Section 312000.
B. Blade or hand grade all subgrade surfaces as required to provide adequate surface, properly sloped for drainage, and in conformance with required elevations.
C. Prior to the start of paving operations, the subgrade surface shall be prepared by filling in wheel ruts, erosions and all other ground disturbances regardless of cause, and the ground surface shall be fine graded so that after proof-rolling the subgrade surface will be at the proper level to receive the pavement.

D. All subgrade earth shall be proof-rolled by means of a roller weighing not less than ten tons or other compaction equipment satisfactory to the Architect and/or Engineer.

E. Any additional unsatisfactory sub-grade soil conditions which are not suitable for the pavement structure shall be reviewed with the Architect or Engineer, who may order corrective undercut and backfill work done after review/approval by the Owner.

F. No paving operations shall commence until finished subgrade elevations and backfill and compaction operations have been completed adjacent to all curbs, catch basins, gutters, manholes and/or any appurtenances or utility structures within the area to be paved.

G. The Architect or Engineer must approve the subgrade prior to placement of the concrete. Installation of all or any portion of the concrete course without subgrade approval by the Architect or Engineer is done at the Contractor's risk.

H. Approval of the subgrade by the Architect or Engineer shall not relieve the Contractor of his responsibility to protect the subgrade from damage caused from excessive moisture, rutting from trucks or heavy equipment, or from any other cause, and any damage occurring to the subgrade either before, or during, the paving operations shall be corrected to the satisfaction of the Architect or Engineer, at the Contractor's expense.

3.3 PREPARATION FOR PAVEMENT INSTALLATION

A. Utility Structures and Appurtenances

(1) After the subgrade surface has been prepared as specified herein, the Contractor shall check all frames, covers, grates, water valve boxes and all other miscellaneous castings that are located in the proposed pavement areas to ensure that all such items have been accurately positioned and set to the proper slope and elevation. All covers and grates are to be set flush with the required finish pavement surface. No depressions or mounds will be permitted in the pavement to accommodate inaccuracies in the setting of these appurtenances. All corrective work as may be necessary shall be done at the Contractor's expense.

B. Meeting Existing Pavements

(1) Where new pavements are to meet existing pavements, the Contractor shall saw cut the existing pavements with mechanical cutting tools so that there will be a vertical butting surface between the old and new pavements. Line cutting of existing pavements shall be along neat, straight and even lines, and shall be done in such a manner so as not to damage the adjacent pavement which is to remain.

(a) Any cutting and replacement of pavement and base within a public right-of-way shall conform to all requirements of the public jurisdiction having authority of the right-of-way, without limitation and/or additional cost to the Owner.

C. Soil Sterilization
(1) Prior to paving operations, all paved areas shall be sterilized by application of granular or liquid herbicide treatment.
(2) Soil sterilization shall be placed immediately prior to placement of the rock base.
(3) Treatment shall be installed in strict conformance with manufacturer's instructions.

D. Forms

(1) Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces unless otherwise specified.
(2) Use flexible or curved forms for curves with a radius of 100 feet or less.
(3) Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

3.4 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast in. Notify other trades to permit installation of their work.
B. Remove snow, ice, or frost from subbase surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.
C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
E. Do not add water to concrete during delivery or at Project site.
F. Do not add water to fresh concrete after testing.
G. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
H. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

(1) Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.
I. Screed pavement surfaces with a straightedge and strike off.
J. Commence initial floating using bull floats or darbies to impart an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
K. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.
L. Comply with the requirements of applicable division 3 sections for temperature modifications during placement, limits of temperature for placement, and other related
3.5 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.
B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

(1) Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

3.6 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
B. Comply with ACI 306.1 for cold-weather protection.
C. Other measures for the curing and protection of the concrete surface outlined in division 3 should be implemented as they are relevant.

3.7 REPAIRS AND PROTECTION

A. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.
B. Drill test cores, where directed by Owner’s Representative, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with Portland cement concrete bonded to pavement with epoxy adhesive.
C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement or until such time as determined by the Engineer. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.
D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

3.8 PREPARATION OF TREATED BASE FOR CEMENT CONCRETE PAVING

A. Contractor shall examine all areas and conditions under which cement concrete paving is to be installed and notify the General Contractor, Architect and/or Engineer in writing of conditions detrimental to the proper completion and timely completion of the specified paving work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Architect and/or Engineer.
B. If subgrade material has worked to the surface, or if any movement is found in the treated base, the Contractor shall remove the soft spot and install treated base at no additional cost to the Owner.

3.9 PAVEMENT MARKINGS
A. Contractor shall provide and install pavement marking paint as specified.
B. Install all markings as shown on the drawings and/or as noted herein including:

   (1) Parking stalls layout lines.
   (2) Handicapped symbol and stripping.
   (3) Traffic control directional arrows and miscellaneous markings.
   (4) Curb painting.

C. Pavement marking shall be installed per manufacturer's specifications and instructions.

3.10 CLEAN UP

A. Remove all excess material and debris from site.
B. Clean all surfaces of other materials. Any staining which cannot be removed shall be replaced at the contractor's expense.
C. Remove equipment and barricades from site.

END OF SECTION 32 131 3
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SECTION 32 31 19 - DECORATIVE METAL FENCES AND GATES

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. Decorative aluminum fence.

B. Related Requirements:
   1. Section 03 30 00 "Cast-in-Place Concrete" for concrete post concrete fill.

1.3 PREINSTALLATION MEETINGS

A. Pre-installation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For fence. Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each fence material and for each color specified.

1.5 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For decorative metallic-coated-steel tubular picket fences, including finish, indicating compliance with referenced standard and other specified requirements.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For gate operators to include in maintenance manuals.
1.7 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

PART 2 - PRODUCTS

2.1 DECORATIVE ALUMINUM FENCES

A. Decorative Aluminum Fences: Fences made from aluminum extrusions.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

   a. Alumi-Guard, Inc.
   b. Carfaro, Inc.
   c. Delair Group, L.L.C.
   d. East & West Alum Craft Ltd.
   e. Elegant Aluminum Products, Inc.
   f. Elite Fence Products, Inc.
   g. Ideal Aluminum Products.
   h. Iron Eagle Industries, Inc.
   i. Japra Group International.
   k. Master Halco.
   l. Merchants Metals.
   m. Royal Aluminum and Steel, Inc.
   n. Specrail.
   o. Superior Aluminum Products, Inc.
   p. Tek-Rail.
   q. Ultra Aluminum Mfg., Inc.
   r. Virginia Railing and Gates, LLC.

B. Posts: Square extruded tubes.

C. Post Caps: Aluminum castings that cover entire top of posts.

D. Rails: Extruded-aluminum channels, 3-rail fence style as indicated on Drawings.

   1. Pickets: Extruded-aluminum tubes
   2. Picket Spacing: 4 inches on center, maximum.

E. Fasteners: Manufacturer's standard concealed fastening system.

F. Fabrication: Assemble fences into sections by welding pickets to rails.

   1. Fabricate sections with clips welded to rails for field fastening to posts.
   2. Drill clips for fasteners before finishing.
G. Finish exposed welds to comply with NOMMA Guideline 1, Finish #2 - completely sanded joint, some undercutting and pinholes okay.

H. Finish: Baked enamel or powder coating.

2.2 ALUMINUM

A. Aluminum, General: Provide alloys and tempers with not less than the strength and durability properties of alloy and temper designated in paragraphs below for each aluminum form required.

B. Extrusions: ASTM B 221, Alloy 6063-T5.


2.3 COATING MATERIALS

A. Shop Primer for Steel: Manufacturer's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

B. Polyurethane Intermediate Coat and Topcoat: Complying with MPI #72 and compatible with undercoat.

2.4 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

1. For aluminum, provide type and alloy as recommended by producer of metal to be welded and as required for strength and compatibility in fabricated items.

B. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Section 03 30 00 "Cast-in-Place Concrete" with a minimum 28-day compressive strength of 3000 psi, 3-inch slump, and 1-inch maximum aggregate size or dry, packaged, normal-weight concrete mix complying with ASTM C 387/C 387M mixed with potable water according to manufacturer's written instructions.

C. Non-shrink Grout: Factory-packaged, non-staining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M and specifically recommended by manufacturer for exterior applications.
2.5 ALUMINUM FINISHES

A. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 2 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.

B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

1. Construction layout and field engineering are specified in Section 01 73 00 "Execution."

3.3 DECORATIVE FENCE INSTALLATION

A. Install fences according to manufacturer's written instructions.

B. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.

END OF SECTION 32 31 19
SECTION 32 32 15 – PRECAST MODULAR BLOCK GRAVITY RETAINING WALLS

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 single-depth precast concrete modular block (PMB) retaining walls without geosynthetic soil reinforcement. Wall blocks under this section shall be cast utilizing a wet-cast concrete mix and exhibit a final handling weight in excess of 1,000 pounds (450 kg) per unit.

B. Related Requirements:

1. Section 31 20 00 "Earth Moving" for excavation for segmental retaining walls.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each color and texture of concrete unit specified. Submit full-size units and sections of units not less than 3 inches (75 mm) square.

C. Delegated-Design Submittal: For segmental retaining walls.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Product Certificates: For each type of segmental retaining wall unit from manufacturer.

1. Include test data for shear strength between segmental retaining wall units according to ASTM D 6916.

2. Include test data for connection strength between segmental retaining wall units and soil reinforcement according to ASTM D 6638.
C. Product Test Reports: For each type of segmental retaining wall unit for tests performed by a qualified testing agency.
   1. Include test data for freeze-thaw durability of segmental retaining wall units.
   2. Include test data for shear strength between segmental retaining wall units according to ASTM D 6916.
   3. Include test data for connection strength between segmental retaining wall units and soil reinforcement according to ASTM D 6638.

D. Research/Evaluation Reports: For segmental retaining wall units, from ICC-ES.

E. Preconstruction test reports.

F. Source quality-control reports.

G. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects.
   1. Build mockup of segmental retaining wall approximately 72 inches (1800 mm) long by not less than 36 inches (900 mm) high above finished grade at front of wall.
      a. Include typical soil reinforcement.
      b. Include typical base and cap or finished top construction.
      c. Include backfill to typical finished grades at both sides of wall.
      d. Include typical end construction at one end of mockup.
      e. Include 36-inch (900-mm) return at one end of mockup, with typical corner construction.
   2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform the following preconstruction testing:
   1. Test soil reinforcement and backfill materials for pullout resistance according to ASTM D 6706.
   2. Test soil reinforcement and backfill materials for coefficient of friction according to ASTM D 5321.
1.8 DELIVERY, STORAGE, AND HANDLING

A. Store and handle concrete units and accessories to prevent deterioration or damage due to contaminants, breaking, chipping, or other causes.

B. Store geosynthetics in manufacturer's original packaging with labels intact. Store and handle geosynthetics to prevent deterioration or damage due to sunlight, chemicals, flames, temperatures above 160 deg F (71 deg C) or below 32 deg F (0 deg C), and other conditions that might damage them. Verify identification of geosynthetics before use, and examine them for defects as material is placed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Basis of Design: Design of segmental retaining walls is based on products indicated. If comparable products of another manufacturer are proposed, engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design segmental retaining walls.

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design segmental retaining walls.

C. Compliance Review: Qualified professional engineer responsible for segmental retaining wall design shall review and approve submittals and source and field quality-control reports for compliance of materials and construction with design.

D. Structural Performance: Engineering design shall be based on the following loads and be according to NCMA's "Design Manual for Segmental Retaining Walls."

   1. Gravity loads due to soil pressures resulting from grades and backfill as outlined in the Slope Stability Analyses report performed and included in the project Specifications.
   2. Any superimposed loads (surcharge) as indicated on Drawings and outlined in the Slope Stability Analyses report performed and included in the project Specifications.
   3. Design wall for seismic resistance based on $S_d = 0.37g$.

2.2 PRECAST MODULAR BLOCK RETAINING WALL UNITS

A. Concrete Units: Wet-cast precast modular retaining wall units conforming to ASTM C 1776, Normal Weight, except that maximum water absorption shall not exceed 7 percent by weight and units shall not differ in height more than plus or minus 3/16 inch (4.7 mm) from specified dimension.

   1. Basis-of-Design Product: Redi-Rock Retaining Wall Systems as licensed by Redi-Rock International, LLC as indicated on drawings or comparable approved product.
   2. Provide units that comply with requirements in ASTM C 1372 for freeze-thaw durability.
   3. Provide units that interlock with courses above and below by means of integral shear knobs, as per basis-of --design manufacturer standard.
B. Type: Gravity-Wall Design

C. Color: As selected by Architect from manufacturer's full regional color range at no additional project cost. A buff/tan block color is desired.

D. Shape and Texture: Provide units matching basic shape, dimensions, and face texture of basis-of-design product as indicated on the drawings.

E. Batter: Provide units that offset from course below to provide at least 5 degree batter as indicated in drawings.

F. Cap Units: Provide cap units of shape indicated in drawings with smooth, as-cast top surfaces without holes or lugs. Top block shape to be cupped as per basis-of-design manufacturer standard.

G. Special Units: Provide finished corner units, end units, and other shapes as needed to produce segmental retaining walls of dimensions and profiles indicated and to provide texture on all exposed face surfaces matching face texture of standard unit blocks.

H. Block Size: As per basis-of-design manufacturer standard, standard nominal block unit height of 18 inches (457 mm).

2.3 INSTALLATION MATERIALS

A. Leveling Base: Comply with requirements in Section 312000 "Earth Moving" for base drainage course. The precast modular block units shall be placed on a leveling pad constructed from crushed stone or unreinforced concrete. The leveling pad shall be constructed to the dimensions and limits shown on the retaining wall design drawings by the delegated design retaining wall engineer.

1. Leveling Course: Lean concrete option used for the construction of an unreinforced leveling pad shall satisfy the criteria for AASHTO Class B. The concrete should be cured a minimum of 12 hours prior to placement of the precast modular block wall retaining units and exhibit a minimum 28-day compressive strength of 2500 psi (17.2 MPa).

B. Drainage Fill: Comply with requirements in Section 312000 "Earth Moving" for drainage course. Drainage aggregate (and wall infill for retaining walls designed as modular gravity structures) shall be durable crushed stone conforming to No. 57 size per ASTM C33 with the following particle-size distribution requirements per ASM D422:

<table>
<thead>
<tr>
<th>U.S. Standard Sieve Size</th>
<th>% Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1/2” (38 mm)</td>
<td>100</td>
</tr>
<tr>
<td>1” (25 mm)</td>
<td>95-100</td>
</tr>
<tr>
<td>½” (13 mm)</td>
<td>25-60</td>
</tr>
<tr>
<td>No. 4 (4.76 mm)</td>
<td>0-10</td>
</tr>
<tr>
<td>No. 8 (2.38 mm)</td>
<td>0-5</td>
</tr>
</tbody>
</table>
C. Nonreinforced-Soil Fill: Comply with requirements in Section 312000 "Earth Moving" for satisfactory soils.

D. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

E. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent.

1. Apparent Opening Size: No. 70 to 100 (0.212- to 0.150-mm) sieve, maximum; ASTM D 4751.
2. Minimum Grab Tensile Strength: 110 lb (49.9 kg); ASTM D 4632.
3. Minimum Weight: 4 oz./sq. yd. (132 g/sq. m).
4. Manufacturers: Subject to compliance with requirements, provide one of the following nonwoven geotextile products (or approved equal):
   a. Mirafi 140N
   b. Propex Geotex 451
   c. Skaps GT-142
   d. Trace-Linq 140EX
   e. Carthage Mills FX-40HS
   f. Stratatex ST 142

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for excavation tolerances, condition of subgrades, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 RETAINING WALL INSTALLATION

A. General: Place units according to NCMA's "Segmental Retaining Wall Installation Guide" and segmental retaining wall unit manufacturer's written instructions.

   1. Lay units in basis-of-design manufacturer’s recommended pattern for block and texture/shape type.
   2. Form corners and ends by using special units.

B. Do not use units with chips, cracks, or other defects that are visible at a distance of 20 feet (6 m) where such defects are exposed in the completed Work.

C. Leveling Base: Place and compact base material to thickness indicated and extend to the limits indicated and with not less than 95 percent maximum dry unit weight according to
ASTM D 698. The leveling pad shall be constructed to provide a level, hard surface on which to place the first course of precast modular block units.

1. Crushed Stone Leveling Pad: Crushed stone shall be placed in uniform maximum lifts of 6” (150 mm). The crushed stone shall be compacted by a minimum of 3 passes of a vibratory compactor capable of exerting 2,000 lb (8.9 kN) of centrifugal force and to the satisfaction of the Inspection Engineer.

2. Unreinforced Concrete Leveling Pad: At Contractor’s option, unreinforced lean concrete may be substituted. The concrete shall be placed in the same dimensions as those required for the crushed stone leveling pad. The Retaining Wall Installation Contractor shall erect proper forms as required to ensure the accurate placement of the concrete leveling pad.

D. First Course: Place first course of segmental retaining wall units for full length of wall. Place units in firm contact with each other, properly aligned and level.

1. Tamp units into leveling base as necessary to bring tops of units into a level plane.

E. Subsequent Courses: Remove excess fill and debris from tops of units in course below. Place units in firm contact, properly aligned, and directly on course below.

1. For units with shear knobs designed to fit into holes in adjacent units, lay units so knobs are accurately aligned with holes, and bedding surfaces are firmly seated on beds of units below.

3.3 FILL PLACEMENT

A. General: Comply with requirements in Section 31 20 00 "Earth Moving," with NCMA's "Segmental Retaining Wall Installation Guide," and with segmental retaining wall unit manufacturer's written instructions.

B. Fill voids between and within units with drainage fill. Place fill as each course of units is laid.

C. Place, spread, and compact drainage fill and soil fill in uniform lifts for full width and length of embankment as wall is laid. Place and compact fills without disturbing alignment of units. Where both sides of wall are indicated to be filled, place fills on both sides at same time. Begin at wall, and place and spread fills toward embankment.

1. Use only hand-operated compaction equipment within 48 inches (1200 mm) of wall, or one-half of height above bottom of wall, whichever is greater.

2. Compact reinforced-soil fill to not less than 95 percent maximum dry unit weight according to ASTM D 698.

   a. In areas where only hand-operated compaction equipment is allowed, compact fills to not less than 90 percent maximum dry unit weight according to ASTM D 698.

3. Compact nonreinforced-soil fill to comply with Section 31 20 00 "Earth Moving."
D. Place a layer of drainage fill at least 12 inches (300 mm) wide behind wall to within 12 inches (300 mm) of finished grade. Place a layer of drainage geotextile between drainage fill and soil fill.

E. Wrap subdrainage pipe with filter fabric and place in drainage fill as indicated, sloped not less than 0.5 percent to drain. Drainage pipe shall be 4” (100 mm) diameter, 3-hole perforated, HDPE pipe with a minimum stiffness of 22 psi (152 kPa) per ASTM D2412.

1. The drainage pipe shall be manufactured in accordance with ASTM D1248 for HDPE pipe and fittings.
2. Basis-of-Design Drainage Pipe Products: Provide for ADS 3000 Triple Wall pipe as manufactured by Advance Drainage Systems or approved equal product.

F. Place impervious fill over top edge of drainage fill layer.

G. Slope grade at top of wall away from wall unless otherwise indicated. Slope grade at wall base away from wall. Provide uniform slopes that prevent ponding.

3.4 CONSTRUCTION TOLERANCES

A. Variation from Level: For bed-joint lines along walls, do not exceed 3/4 inches in 10 feet (19 mm in 3 m).

B. Variation from Indicated Batter: For slope of wall face, do not vary from indicated slope by more than 1/2 inches in 10 feet (13 mm in 3 m).

C. Maximum Gap between Units: 1/8 inch (3 mm).

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections. Contractor to coordinate and schedule all testing and inspections with the testing agency.

B. Comply with requirements in Section 312000 "Earth Moving" for field quality control.

1. In each compacted backfill layer, perform at least one field in-place compaction test for each 150 feet (45 m) or less of segmental retaining wall length.
2. In each compacted backfill layer, perform at least one field in-place compaction test for each 24 inches (600 mm) of fill depth and each 50 feet (15 m) less of segmental retaining wall length.

3.6 ADJUSTING

A. Remove and replace segmental retaining wall construction of the following descriptions:

1. Broken, chipped, stained, or otherwise damaged units. Units may be repaired if Architect approves methods and results.
2. Segmental retaining walls that do not match approved Samples and mockups.
3. Segmental retaining walls that do not comply with other requirements indicated.
B. Replace units so segmental retaining wall matches approved Samples and mockups, complies with other requirements, and shows no evidence of replacement.

END OF SECTION 32 32 15
SECTION 32 84 00 - PLANTING IRRIGATION

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. General.

1. Provide and install a complete design build irrigation system that is compatible with the Landscape shown on the Construction Documents. Irrigation system to provide coverage for all seeded and sodded areas, all plantings adjacent to the building, all plantings in parking lot islands, and all plantings near and in the bio-retention and detention basins. Irrigation of turf and plantings shall be on separate zones. Irrigation is not needed at the native seed areas, however provide quick couplers for use in providing temporary irrigation during initial establishment period.

2. Irrigation system shall include all controllers, backflow preventers, piping, valves, sprinklers, quick couplers, moisture sensor, and booster pumps.

1.2 QUALITY ASSURANCE

A. Manufacturing Qualifications.

1. Provide the landscape irrigation system as a complete unit produced by the manufacturers specified for all portions of the work including heads, valves, piping circuits, controller, and accessories. Materials shall be purchased from a local distributor of the specified products. The products specified for this project were specifically selected for this irrigation system.

B. Installer Qualifications.

1. Acceptable installers per General Conditions of Specifications.

C. Testing.

1. Pressure testing/verification shall be the responsibility of the irrigation contractor.

D. Requirements of Regulatory Agencies.

1. System shall comply with the requirements of state and local codes and ordinances.

2. Electrical devices shall carry Underwriters’ Laboratory labels.

1.3 REFERENCES

A. ASTM D2241 - Polyvinyl chloride plastic pipe.

B. ASTM D2564 - Solvent cement for polyvinyl chloride plastic pipe and fittings.
1.4 SUBMITTALS

A. As-Builts.
   1. Submit ‘As-Built’ drawings after Substantial Completion.
   2. As-Built drawings shall be blackline prints (2 copies), same size as the original drawings.

B. Manufacturer’s Data.
   1. Submit two copies of manufacturer’s specifications and instructions for any materials and products to be substituted for those specified, no later than 10 business days prior to original bid date.

1.5 GUARANTEE

A. The Contractor shall furnish a written warranty to the effect that all materials and work furnished under this section is warranted for at least one year (from date of ‘Finish-out’), shall be free from defects and faulty workmanship and that any defective material or work shall be promptly repaired or replaced without additional cost to the Owner.

1.6 PROJECT/SITE CONDITIONS

A. Protection.
   1. Protect structures, streets, curbs, sidewalks, fences, walls, trees and other existing features from damage.

1.7 SEQUENCING/SCHEDULING

A. Irrigation system shall be installed and made operable before any seeding and sodding operations commence. In all affected areas, the ground should be restored to its original grade as existed just before installation began. Sprinklers shall be lowered or raised, as necessary, to meet grade after ground has settled.

1.8 OPERATION AND MAINTENANCE

A. Provide instructions covering full operation, care and maintenance of system and controls. Also provide manufacturers’ parts catalogs.

B. Provide schedule showing length of time each valve is to be open (during May, July and September) to serve as a guide for the owner in establishing an appropriate ‘water-window’, which is meant to be between 5-8 hours, for half the zones. Alternate operating half the zones on an every-other night basis (between 1-7:00 am) for a deeper watering followed by depletion period.
PART 2 - PRODUCTS

2.1 MATERIALS

A. Backflow Preventer.
   1. Reduced-pressure assembly backflow preventer to be provided, installed inside and tested by others according to local codes/regulations.

B. Automatic Controller.
   1. Standard:
      a. Wall-mounted Rainbird ESP-LXME or Toro Custom Command, or functionally equivalent.
      b. Rain sensor: mount Rainbird WR2-RC or Toro TWRS on eave, as shown, with receiver mounted on exterior wall, just outside of controller.

C. Controller - Valve Communications.
   1. Communication between controllers and the control valves shall be accomplished by single strand #14 gauge wire. (Common wire shall be white #12 gauge).

D. Valves/Controls.
   1. Quick coupling valves.
   2. Rainbird #44-NP (1” two-piece body with purple locking rubber cover), or functionally equivalent.
   3. Supply appropriate matching key and hose ell.
   4. All quick coupling valves shall be connected to the mainline by Spears or Lasco 1” triple-elbow swing joints and placed in valve boxes.
   5. Automatic valves: The automatic control valves shall be plastic valves operated by low-power solenoid, normally closed, with manual flow-control adjustment, as indicated on plans.
   6. 1” Valves: Rainbird #100-PGA with flow-control or Toro #254-06-04 with flow

E. Valve Enclosure.
   1. Control valves, gate valves and quick-coupling valves shall be enclosed in a fiberglass valve box such as Carson, Rainbird, or approved equal. Valve boxes are to be filled with a minimum of 6” of washed gravel below pipe level to insure adequate drainage. Quick-couplers shall be in 10” round boxes; single or double control valves shall be in rectangular ‘standard’ valve boxes; drip-zone valve kits shall be in ‘standard’ valve boxes.

F. Pipe.
   1. Main line piping shall be Class 200 polyvinyl chloride (PVC) solvent-weld pipe as manufactured by Eagle or Cresline, or other approved equal. Pipe shall carry the N.S.F. seal of
approval and meet the following specifications: ASTM D-2241, SDR 21 or latest revisions. Lateral pipes shall be Class 160 (or Class 200 for 1”) PVC, SDR 26, solvent-weld pipe. Laterals of 1” size and smaller may be polyethylene pipe (NSF 100psi) with appropriate clamps.

G. Sleeves.
1. Sleeves shall be twice the nominal size of the pipe to be carried within, unless noted differently. Sleeves for control wire only shall be 2” diameter, placed alongside (or above) each sleeve for the mainline.
2. Under paving and where indicated on drawings, install sleeves as follows: 6” and larger shall be Class 200 PVC, while 4” and smaller shall be Schedule 40 PVC (ASTM D-1785). Tape ends of sleeves and mark sleeve locations with above grade stakes with appropriate annotation, i.e. “irrigation sleeves”. Stakes shall be protected. Do not backfill over sleeve locations behind back of curbs or along walk edges, until work has been completed.

H. Pipe Fittings.
1. For main and laterals, PVC fittings shall be solvent weld Schedule 40 standard weight. Attachment shall be made with both a primer and solvent cement, as approved by the manufacturer.

I. Sprinkler Heads.
1. Spray Heads
   a. The spray head bodies shall be either Rainbird 1804 Series or Toro 570Z; spray nozzles shall be MPR nozzles (male-threaded for Toro; female-threaded for Rainbird). For areas 15’ and smaller, and side/end-strips
   b. In areas designated on plan, where spacings are between 15-28 feet, use MP Rotator nozzles (MP1000, 2000 or 3000, as specified and noted in Legend) on Rainbird 1800 or Toro 570Z bodies.
2. Rotors
   a. Single-stream, mid-range rotors shall be Rainbird 5004 with Rainbird’s MPR nozzles, or Toro’s T5 rotor.

J. Sprinkler Risers.
1. Sprinkler heads are to be connected to the laterals by poly flex-pipe and associated fittings, either by Rainbird or Irritrol.

K. Drip Irrigation
1. In beds/areas where designated on the plan, provide drip-irrigation, as described below.
2. Continuously self-flushing, pressure-compensating dripline. Either Netafim’s Techline-CV (#TLCV-06-18, with built-in check-valves) or Rainbird’s XF-CV Series dripline (#XFD-CV-06-18) shall consist of low-density, linear poly-tubing housing internal
pressure compensating, self-flushing, integral drip emitters. The tubing shall be brown or maroon in color. The emitters should have the ability to independently regulate discharge rates, with an output pressure of between 15-40 psi, at a constant flow. The emitter discharge rate shall be 0.6 gallons per hour, utilizing a combination turbulent flow/reduced pressure cell mechanism and a diaphragm to maintain uniform discharge rates. The emitters shall continuously clean themselves while in operation. The dripline shall have the 0.6 gph emitters spaced 18” apart, with an 18” spacing between drip laterals (rows), providing a precipitation rate of approximately 0.43 inches/hr.

3. Accessories: The disc-filters, flush-valves and air-relief valve shall all be manufactured specifically for use with micro-irrigation applications.

L. Booster Pump. (if needed)

1. Sta-Rite model #JHC (for a 30 psi boost), model #JMC (for a 22 psi boost) or #DPC (for a 25 psi boost); each is 1/2 hp, 115V, single-phase and shall be submitted for approval.
2. Munro pump-start relay, connecting controller to pump (StartBox)

M. Manufacturer/Supplier.

1. The materials chosen for the design of the sprinkler system have been specifically referred to by manufacturer, enabling the Owner to establish the level of quality and performance required by the system design. After award of contract and prior to beginning work, the contractor shall submit for approval three copies of the complete list of materials to be installed. Landscape architect will review submittals and determine if substitutions will be allowed, based on functional equivalency.

N. Acceptable Manufacturers of Whole-good Products.

1. Rainbird (Tucson, Arizona): controller, rotors, spray bodies, valves, drip
2. Toro (Riverside, California): controller, rotors, spray bodies and Precision spray nozzles, valves.
3. Netafim (Fresno, California): drip-irrigation products only

PART 3 - EXECUTION

3.1 WATER SUPPLY

A. Supply to irrigation system shall be from 1.5” municipal water, with a new 1” tap and 1” back-flow preventer (both by others), as shown on the plan. Irrigation contractor is responsible for connecting to the irrigation supply and extending the main (and sleeves) through the wall to connect to the irrigation system.
3.2 SYSTEM DESIGN

A. Lay out work as closely as possible to the drawings. The drawings, though carefully drawn, are generally diagrammatic to the extent that all offsets and fittings are not necessarily shown as they may exist on site.

B. The Contractor shall be responsible for full and complete coverage of irrigated areas as to spacing and precipitation rates being matched and shall make any necessary adjustments to the system at no additional charge to the Owner. Head spacing as shown on the drawings is predicated on the water pressure being approximately 45-50 psi at the rotors and multi-stream nozzle sprinklers. Head spacing shall not exceed 55 percent of manufacturer’s stated diameter. Contractor shall verify existing working pressure before commencing work; design was based on the irrigation supply providing approximately 1-16 gpm at 55-65 psi (after the pump, if used). Revisions to the irrigation system must be submitted to the landscape architect in written form for approval prior to beginning work.

3.3 TRENCHING, BACKFILLING AND COMPACTING

A. Pulling, Excavating and Trenching.

1. Trenching, backfilling and compacting shall be as per Sitework Specifications - Trenching and Backfilling for utilities.
2. If trenching, trenches shall be made wide enough to allow a minimum of 6 inches between parallel pipe lines. If pulling, the same lateral distance shall be observed.

B. Minimum Cover.

1. An absolute minimum of 12 inches cover shall be held over laterals and control wires. Mains shall be 18” (minimum) below finished grade, except where crossing roads. Where crossing under roadways, top of sleeves shall be 18” below subgrade, which is grade before crushed-stone is laid for road bed.

C. Backfill.

1. Backfilling and backfill material shall be as per Sitework Specifications. Backfilling shall be done in 6” layers and compacted after each layer, to prevent excessive settling.
2. Backfilling of trenches containing plastic pipe (2.5” pipe) shall be done when pipe is cool to avoid excessive contraction in cold weather. Such backfilling can be done in early morning hours or the pipe may be water cooled prior to backfilling procedures. Re-seed trenched or disturbed areas to match adjacent existing turfgrass.
3. Where pipe is pulled into the ground, slit-domes shall be compacted to original grade after pulling. Re-seed disturbed areas (slits from pulled pipe) to match adjacent existing turfgrass.

D. Pavements, Walks, Etc.

1. Communication wire must be placed in sleeving under pavement, drives and walks, etc.
2. Sleeves required shall be furnished by this Contractor, unless directed otherwise.
3.4 INSTALLATION

A. General.
   1. Unless otherwise indicated, comply with requirements of the Local Plumbing Code.
   2. Install piping, valves, controls and sprinklers in accordance with manufacturer’s written instructions.

B. Automatic Controllers.
   1. Connect remote control valves to controller in a sequence corresponding with station settings, as denoted on the plan.
   2. Communication circuitry shall be run, wherever possible, along with the mainline pipe.
   3. A minimum of 18 inches of wire shall be left at each decoder to provide slack.
   4. Contractor is responsible for mounting weather-sensor unit according to the manufacturer’s specifications. Calibration process and communication with indoor wall-mounted controller shall also be according to manufacturer’s specifications.

C. Piping.
   1. Pipe may be assembled and welded on the surface.
   2. Plastic pipe and fittings shall be solvent welded using solvents and methods as recommended by manufacturer of the pipe, except where screwed connections are required. Pipe and fittings shall be thoroughly cleaned of dirt, dust and moisture before applying solvent with a non-synthetic bristle brush.
   3. When pipe is pulled into the ground, all PVC pipe shall be solvent welded at least 4 hours before pulling.
   4. Make all connections between plastic pipe and metal valves or steel pipe with threaded fittings using plastic male adapters.
   5. Use dielectric fittings at connection where pipes of dissimilar metal are joined.
   6. Lay pipe on solid sub-base, uniformly sloped without humps or depressions.
   7. Trenches (or pulls) shall be snaked, or the pipe snaked, within the trench to allow for expansion and contraction of pipe.
   8. At wall penetrations, pack the opening around pipe with non-shrink grout. At exterior face, leave a perimeter slot approximately ½” wide by ¾” deep. Fill this slot with backer rod and an acceptable elastomeric sealant. Repair below grade waterproofing disturbed by this work and make penetration watertight.
   9. Install PVC pipe in dry weather when temperature is above 40 degrees F in strict accordance with manufacturer’s instructions. Allow joints to cure at least 24 hours at temperatures above 40 degrees F before testing, unless otherwise recommended by manufacturer.

D. Sprinkler Heads
   1. Install heads at proper grade level as per manufacturer’s recommendation.
   2. Use only Teflon tape for sealing heads and riser assemblies when required.

E. Closing of Pipes and Flushing Lines.
   1. Cap or plug openings as soon as lines have been installed to prevent the entrance of materials that would obstruct the pipe. Leave in place until removal is necessary for comple-
tion of the installation. Thoroughly flush out water lines and before installing heads, valves, and other hydrants.
2. Test in accordance with industry standards and pipe ratings.
3. Upon completion of the testing, the Contractor shall complete assembly and adjust sprinkler heads for proper distribution.

F. Grounding.
1. Manufacturers provide recommended grounding requirements and practices for their controllers. Provide grounding of system components according to manufacturers’ recommendations and guidelines. Ensure that controller is grounded according to manufacturers’ specifications. Show locations and include details of grounding on shop-drawing submittals prior to installation.

3.5 TESTING
A. Operational Testing.
1. Perform operational testing after backfill is completed and sprinkler heads are adjusted to final position.
2. Demonstrate to the Owner that system meets coverage requirements and that automatic controls function properly.
3. Coverage requirements are based on operation of one circuit at a time, unless noted differently.

3.6 TRAINING
A. Personnel Training.
1. Contractor shall be responsible for the training of as many personnel as the Owner shall deem necessary.
2. Contractor shall be responsible for one closing and one opening of the system during the appropriate times of the year as part of the training of the Owner’s personnel.
3. Contractor training shall include general trouble-shooting and operation of the system with reference to head, valve, controller and weather-sensor operation.

3.7 SPARE PARTS
A. Submit spare parts as pertains to warranted materials, described by manufacturers’ warranties.
B. Provide:
1. Two extra sprinkler heads and one extra control valve of each size and type.
2. One extra key and hose-swivel for quick coupling valves.
3. Owners/operational manuals available on controller, heads, valves and weather-sensor.
3.8 CLEAN-UP

A. Remove debris, resulting from work of this Section, from the site.
B. Re-seed trenched or disturbed areas to match adjacent existing turfgrass.

3.9 ADJUSTMENT

A. After completion of grading, seeding or sodding, if applicable, contractor shall return to the jobsite to perform any final adjustments to the system, which might be deemed necessary.
B. Maintenance shall include, in addition to initial start-up, one winterization and one Spring start-up the following year. Re-set heads twice, as directed, if necessary.

END OF SECTION 32 84 00
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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. Turf Seeding.
   2. Sodding.
   3. Turf Renovation.
   4. Erosion-control material(s).

B. Related Sections:
   1. Division 31 Section "Site Clearing" for topsoil stripping and stockpiling.
   2. Division 31 Section "Earth Moving" for excavation, filling and backfilling, and rough grading.
   3. Section 32 93 00 "Plants".

1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

C. Owner: Owner of record or duly authorized agent, including Architect, Landscape Architect, Engineer or Construction Manager.

D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

E. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

F. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete or top surface of a fill or backfill before planting soil is placed.

H. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.

I. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Pesticides, Insecticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging. Investigate sources of supply and confirm they can supply seed in quantity, variety and quality specified before submitting Bid.

C. Certification of each seed mixture for turfgrass sod. Include identification of source and name and telephone number of supplier. Investigate sources of supply and confirm they can supply sod in quantity, variety and quality specified before submitting Bid.

D. Qualification Data: For qualified landscape Installer. Include list of similar projects completed by Installer demonstrating capabilities and experience.

E. Product Certificates: For soil amendments and fertilizers, from manufacturer.

F. Material Test Reports: From a qualified independent testing agency indicating and interpreting test results for existing stockpiled and / or imported topsoil.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified, experienced landscape Installer whose work has resulted in successful turf establishment similar in material, design and extent to that indicated for this project.
   1. Landscape Experience: Five years' minimum experience in turf installation in addition to requirements in Division 01 Section "Quality Requirements." Include lists of five (5) completed projects with project names, addresses and year completed, as well as names and address of owners.
   2. Installer's Field Supervision: Installer to maintain an experienced, qualified full-time supervisor on Project site when work specified within this section is in progress.
B. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Topsoil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; deleterious material; pH; and mineral and plant-nutrient content of the soil.

1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
2. Soil samples to be taken from varied locations to sufficiently document each soil to be used or amended for planting purposes.
3. Payment of analysis is the responsibility of the Contractor.
   a. Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. (92.9 sq. m) or volume per cu. yd. (0.76 cu. m) for nitrogen, phosphorus, and potash nutrients and any limestone, sand or other inorganic / organic soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants. Contractor shall be responsible for implementation of test result recommendations.
   b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action. Should existing soils require extensive incorporation of amendments to correct existing deficiencies or are unsuitable for growth of applicable turf, such soils shall be removed and replaced with suitable topsoil.

D. Pre-installation Conference: Conduct conference at project site.

E. Quantity lists are supplied as a convenience. The Contractor shall verify all quantities. In the event of a discrepancy, the plans shall govern. Failure to verify quantities prior to submission of a bid take shall not relieve responsibility for furnishing plant material in accordance with the Landscape Plans. Any additional expenses, as a result of this failure, shall not be the responsibility of the Owner.

F. Comply with applicable local regulations.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened and undamaged containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable. Protect materials from deterioration during delivery and while stored at site. Owner reserves the right to reject any seed that appears low-quality, packaged with excess inert matter, or otherwise substandard as determined by the Owner.
B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying. Sod shall comply with the state and federal laws with respect to inspection for plant diseases and insect infestation.

C. Bulk Materials:
   1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
   2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
   3. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual grade elevations, above-grade and underground service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work. Perform work in a manner which will avoid damage. Maintain grade stakes until parties concerned mutually agree upon removal. Contact 1-800-DIG-RITE (800-344-7483) prior to digging.

B. Planting Restrictions: Coordinate installation of seed and sod during normal planting seasons as determined by weather conditions and accepted practice. Seeding and sodding may be done under unreasonable conditions without additional compensation, but such work must have prior approval of Owner in writing as to the time of work and methods of operations. Approval to plant under such conditions shall in no way relieve the Contractor from the general provisions of these specifications. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of substantial completion. Seeding and sodding during other times shall require Owner approval.
   1. Spring Sodding: From the time the soil becomes workable and sod becomes available to June 15
   2. Fall Sodding: August 15 to November 1
   3. Spring Turf Seeding: April 1 to June 1
   4. Fall Turf Seeding: August 15 to October 1

C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

1.8 MAINTENANCE SERVICE

A. Initial Turf Maintenance Service: Warrant and provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after
each area is planted and continue until acceptable turf is established but for not less than the following periods:

1. Seeded Turf: 45 days from date of Substantial Completion.
   a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.

2. Sodded Turf: 30 days from date of Substantial Completion.

B. Continuing Turf Maintenance Proposal: From Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

PART 2 - PRODUCTS

2.1 TURF SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with the Association of Official Seed Analysts’ (AOSA) "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species: State-certified seed of grass species as follows, with not less than 90 percent germination, not less than 98 percent pure seed, and not more than 0.05 percent weed seed:

1. Sports Turf Mix as supplied by Belleville Seed House (800) 873-3383 or approved equal. (95% Turf Type (T) Tall Fescue / 5% Kentucky Bluegrass).

2.2 TURFGRASS SOD

A. Turfgrass Sod: Certified complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish fresh cut, viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted. The root zone shall be of good, fertile, natural soil, free from stones and debris. Peat sod will be rejected.

1. Turfgrass Species: Tall Fescue Sport Turf Mixture, a minimum of three (3) cultivars.

2.3 INORGANIC SOIL AMENDMENTS

A. General: Based on recommendations of the Topsoil Analysis, the following amendments may or may not be required. If required, the following specifications apply:

B. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
1. Class: T, with a minimum of 99 percent passing through No. 8 sieve and a minimum of 75 percent passing through No. 60 sieve.

2. Provide lime in form of ground dolomitic limestone.

C. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, and with a minimum of 99 percent passing through No. 6 sieve and a maximum of 10 percent passing through No. 40 sieve.

D. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

E. Aluminum Sulfate: Commercial grade, unadulterated.

F. Perlite: Horticultural perlite, soil amendment grade.

G. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 sieve.

H. Sand: Clean, washed, FA2 (Course Sand), and free of toxic materials.

I. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.

J. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

2.4 ORGANIC SOIL AMENDMENTS

A. Peat: Domestic peat composed of not less than 90% of decomposed organic matter by weight on oven-dried basis. Peat shall be delivered in a workable condition, with uniform texture and free from lumps.

B. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.5 FERTILIZERS

A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 20 percent phosphoric acid.

B. Slow-Release Fertilizer: Granular, non-burning fertilizer consisting of 50 percent polymer-coated nitrogen, phosphorus, and potassium in the following composition:

1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory. In the absence of a soil report, provide a starter analysis of 6-24-24 and a post-emergent analysis of 25-0-10 or similar approved composition.
2.6 TOPSOIL

A. Topsoil: ASTM D 5268, pH range of 6 to 7, minimum 5 percent organic material content, fertile, friable, free of stones ½ inch or larger in any dimension, roots, plants, sod, clods, clay lumps, pockets of coarse sand, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials harmful to plant growth; free of obnoxious weeds and invasive plants including quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass; not infested with nematodes; grubs; or other pests, pest eggs, or other undesirable organisms and disease-causing plant pathogens; friable and with sufficient structure to give good tilth and aeration. Continuous, air-filled pore space content on a volume/volume basis shall be at least 15 percent when moisture is present at field capacity.

B. Topsoil Source: Topsoil for landscape operations shall be obtained from the stripping of on-site topsoil, possibly supplemented with material imported from off-site. Verify suitability of soil to produce topsoil meeting requirements and amend. Supplement with imported topsoil when quantities are insufficient. Imported topsoil shall be obtained from a naturally, well-drained, arable site where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes.

2.7 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free threshed straw of wheat, rye, oats, or barley, of proper consistency for placing with commercial mulch blowing equipment.

B. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

C. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

D. Tackifier: Liquid concentrate diluted with water forming a transparent 3-dimensional-like crust permeable to water and air and containing no agent toxic to seed germination and growth.

2.8 PESTICIDES / HERBICIDES

A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction. Herbicides shall contain colored dye to aid in identification of areas that have received herbicide treatment. Contractor to maintain at job site all current pesticide applicator’s licenses, herbicide labels, and Material Safety Data Sheets (MSDS) for all chemicals utilized during the completion of the work. Chemicals used shall have the lowest environmental impact. Organic practices shall be utilized wherever practical.
B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

2.9 EROSION-CONTROL MATERIALS

A. Erosion-Control Blankets for Turf Areas: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable netting structure. Include manufacturer's recommended biodegradable fasteners.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.

1. Examine the work of all other trades and verify that all such work is complete to the point that this installation may properly commence.
2. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
3. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
4. Verify that elevations and water levels meet original design and construction documentation.
5. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
6. Uniformly moisten excessively dry soil that is not workable, and which is too dusty.

B. Proceed with installation only after unsatisfactory conditions have been corrected, including grade elevations and soil conditions. Starting work constitutes acceptance of existing conditions, including current water levels and soil condition, under which work is to be performed. After such acceptances, Contractor shall be responsible for correcting unsatisfactory and defective work resulting from such unsatisfactory conditions.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil. If area to be seeded was treated with herbicide, seeding shall occur no less than 14 days after herbicide application.
3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
2. Protect grade stakes set by others until directed to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 SEEDBED PREPARATION

A. Limit subgrade preparation to areas to be planted in the immediate future.

B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 4 inches. Remove stones larger than ½ inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Spread planting soil to a depth required meeting thickness, grades and elevations shown, after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet. Add specified soil amendments and mix thoroughly into upper 4 inches of topsoil. Delay mixing fertilizer with planting soil if planting will not proceed within a few days. If required, mix lime with dry soil before mixing fertilizer.

   a. Spread approximately ½ the thickness of planting soil over loosened subgrade. Work into top of loosened subgrade to create a transition layer. Spread remainder of planting soil.
   b. Reduce elevation of planting soil to allow for soil thickness of sod.

C. Unchanged Subgrades: If seed is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:

1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
2. Loosen surface soil to a depth of at least 6 inches. Apply required soil amendments and initial fertilizers and mix thoroughly into top 4 inches of soil. Till soil to a homogeneous mixture of fine texture
3. Remove stone larger than ½” in any dimension and sticks, roots, trash, and other extraneous matter.
4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.

D. Finish Grading: Grading must be completed with minimal compaction of both subgrade and surface soil. Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to drain and to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.
E. Before planting, obtain Owner’s acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 PREPARATION FOR EROSION-CONTROL MATERIALS

A. Prepare area as specified in "Seedbed Preparation" Article. Install blanket in the same day as seeding.

B. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.

3.5 SEEDING

A. Vegetation zones identified on the plans shall contain the specified mix of species at the specified rates. Ensure that all species within the mix are evenly distributed over the entire area to be seeded. Seeding activities shall be performed after the seedbed has been properly prepared and following tree, shrub and/or container plant installation. The Contractor shall stake, flag or otherwise demarcate the boundaries of all seeding zones for acceptance by the Owner prior to commencement of seeding.

B. Sow turf seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.

1. Do not use wet seed or seed that is moldy or otherwise damaged.
2. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

C. Sow turf seed at a total rate of 350 pounds per acre.

D. Rake turf seed lightly into top 1/8 inch - 1/4 inch of soil, roll lightly, and water with a fine spray.

E. Within 24 hours protect seed on slopes and in drainageways, with erosion-control blankets installed and secured according to manufacturer's written instructions, and as defined on Civil Engineering documents. Utilize biodegradable fasteners and follow manufacturer's specifications. Contractor is responsible for repairing wash outs where blanket is not installed. In areas not designated for receipt of erosion control blankets on Civil Engineering documents, protect seed with either blankets or by spreading straw mulch. Spread straw uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment. Anchor by crimping into soil with suitable mechanical equipment or applying a tackifier. Hydromulch may also be utilized to protect seeded areas not designated to receive blankets, with approval from Owner. Apply at a rate so that mulch component is deposited at not less than 250-lb/acre dry weight.
3.6 HYDROSEEDING

A. Hydroseeding: Hydroseeding of lawn areas must receive Owner’s approval if utilized in lieu of the mechanical seeding process. If approved, mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.

1. Mix slurry with nonasphaltic tackifier.
2. Apply slurry coat at a rate so that mulch component is deposited at not less than 250-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.

3.7 SODDING

A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

1. Lay sod across angle of slopes exceeding 1:3.
2. Anchor sod on slopes exceeding 1:4 with wood pegs spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.

C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.8 TURF RENOVATION

A. Renovate existing turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.

1. Reestablish turf where settlement or washouts occur or where minor regrading is required.
2. Install new planting soil as required.

B. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.

C. Remove topsoil containing foreign materials such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.

D. Mow, dethatch, core aerate, and rake existing turf.

E. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.
F. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.

G. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.

H. Apply soil amendments and initial fertilizers required for establishing new turf and mix thoroughly into top 4 inches of existing soil. Install new planting soil to fill low spots and meet finish grades.

I. Apply sod as required for new turf.

J. Water newly planted areas and keep moist until new turf is established.

3.9 TURF MAINTENANCE

A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf, free of weeds, diseases or other visible imperfections. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: In the absence of an irrigation system, Contractor to install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water turf with fine spray at a minimum rate of 1 1/2 inches per week unless rainfall precipitation is adequate.

C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. Turf shall be mown a minimum of two times. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain optimal grass height.

D. Turf Post-fertilization: Apply fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft to turf area.
3.10 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Owner:

1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds, disease, insects and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 6 by 6 inches.

2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.

B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.11 PESTICIDE / HERBICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated non-native and/or otherwise objectionable weeds and in accordance with manufacturer's written recommendations. Herbicides may be applied using a backpack sprayer or a hand-held wick applicator. Care should be taken not to affect surrounding desirable vegetation.

3.12 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect temporary fencing or barricades and warning signs as required protecting newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

C. Remove non-degradable erosion-control measures after grass establishment period.
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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. Plants.
   2. Planting soils and amendments.
   3. Tree stabilization.
   4. Fertilizers and mulches.
   5. Repairing existing areas damaged by work.

B. Related Sections:
   1. Section01 56 39 "Temporary Tree and Plant Protection" for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
   2. Division 31 Section "Site Clearing" for protection of existing trees and plantings, topsoil striping and stockpiling, and site clearing.
   3. Division 31 Section "Earth Moving" for excavation, filling, and rough grading and for
   4. Section 32 92 00 "Turf and Grasses" for turf and erosion-control materials.
   5. Division 33 Section "Subdrainage" for below-grade drainage of landscaped areas, paved areas, and wall perimeters.

1.3 UNIT PRICES

A. Work of this Section is affected by unit prices specified in Division 01 Section "Unit Prices."
   1. Unit prices apply to authorized work covered by quantity allowances.
   2. Unit prices apply to additions to and deletions from Work as authorized by Change Orders.

1.4 DEFINITIONS

A. Arborist: Certified by ISA or licensed in the jurisdiction where Project is located.

B. Backfill: The earth used to replace or the act of replacing earth in an excavation.
C. Ball and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.

D. Bare-Root Stock: Plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than minimum root spread according to ANSI Z60.1 for type and size of plant required. Bare root stock will not be allowed on this project.

E. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required. Container shall not strangle or girdle natural growth of plant.

F. Finish Grade: Elevation of finished surface of planting soil.

G. Owner: Owner of record or duly authorized agent, including Architect, Landscape Architect, Engineer or Construction Manager.

H. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

I. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

J. Planting Area: Areas to be planted.

K. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

L. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.

M. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

N. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees and shrubs below the soil surface.

O. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

P. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
Q. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated, including soils.

1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials. Plant material shall be obtained locally. Investigate sources of supply and satisfy that they can supply plants itemized on plant list in sizes, variety and quality noted and specified prior to bidding. Failure to take this precaution shall not relieve responsibility of furnishing and installing plant material in accordance with Contract requirements. Any additional expenses, as a result of this failure, shall not be the responsibility of the Owner.

2. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to the Project.

B. Samples for Verification: For each of the following:

1. Organic Mulch: 1-quart (1-liter) volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.

C. Qualification Data: For qualified landscape Installer and Arborist. Include list of similar projects completed by Installer and Arborist demonstrating capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.

D. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:

1. Manufacturer's certified analysis of standard products, rates of application and anticipated uses of fertilizer, insecticide, fungicide and antidesiccant, if applicable.
2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
3. Label data and certificates of inspection substantiating that plant materials comply with requirements of governing authorities with respect to plant diseases and insect infestation and as specified herein.

E. Material Test Reports: From a qualified independent testing agency indicating and interpreting test results for existing stockpiled and / or imported topsoil.

F. Planting Schedule: Indicate anticipated dates and locations for each type of planting.

G. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before start of required maintenance periods.

H. Warranty: Sample of special warranty.
1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants similar in material, design and extent to that indicated for this Project.

1. Experience: Five years' minimum experience in landscape installation in addition to requirements in Division 01 Section "Quality Requirements."
2. Installer's Field Supervision: Require installer to maintain an experienced full-time supervisor on Project site when work is in progress.

B. Soil-Testing Laboratory Qualifications: An independent or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Topsoil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; deleterious material; pH; and mineral and plant-nutrient content of the soil.

1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
2. Soil samples to be taken to sufficiently document on-site condition of individual areas to be planted.
3. Payment of analysis is the responsibility of the Contractor.
4. Report suitability of tested soil for plant growth prior to installation of plant materials and addition of any specified amendments.

   a. Based upon the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. (92.9 sq. m) or volume per cu. yd. (0.76 cu. m) for nitrogen, phosphorus, and potash nutrients and any limestone, sand or other inorganic / organic soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants. Contractor shall be responsible for implementation of test result recommendations.

   b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action. Should existing soils require extensive incorporation of amendments to correct existing deficiencies or are unsuitable for growth of applicable plant materials, such soils shall be removed and replaced with suitable topsoil.

D. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

E. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.

1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not
measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger sizes.

2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

F. Plant Material Observation: Owner may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Owner retains right to observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

G. Preinstallation Conference: Conduct conference at Project site.

H. Plant Quantities: Quantity lists are supplied as a convenience. Contractor shall verify all quantities. Failure to verify quantities prior to submission of a bid shall not relieve responsibility of furnishing plant materials in accordance with the Landscape Plans. Any additional expenses, as a result of this failure, shall not be the responsibility of the Owner.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened, undamaged containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws if applicable. Protect materials from deterioration during delivery and while stored at site.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

3. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

C. Deliver freshly dug trees and shrubs. Heeled-in plants or plants for cold storage are not acceptable unless Contractor makes such a request in writing and plants are subsequently inspected and approved. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling. Plants having broken or cracked balls will be rejected.

D. Handle planting stock by root ball.

E. Deliver plants after preparations for planting have been completed and install immediately. If planting is delayed more than six hours after delivery, set plants in shade, protect from weather and mechanical damage, and keep roots moist.
1. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
2. Do not remove container-grown stock from containers before time of planting.
3. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly-wet condition.
4. Plants shall not remain unplanted longer than 3 days.

1.8 PROJECT CONDITIONS

A. Field Measurements: Verify actual grade elevations, above-grade and underground service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work. Perform work in a manner which will avoid damage. Contact 1-800-DIG-RITE (800-344-7483) prior to digging.

B. Excavation: When conditions detrimental to plant growth are encountered (rubble fill, adverse drainage or obstructions), notify Owner before planting. Excavation shall not be performed when soil is frozen, snow-covered or muddy.

C. Interruption of Existing Services or Utilities: Do not interrupt services or utilities to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary services or utilities according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of each service or utility.
2. Do not proceed with interruption of services or utilities without Owner's written permission.

D. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.

1. Spring Planting: Perform from time soil becomes workable to June 1.
2. Fall Planting: Perform from September 1 to November 15. Evergreen shrub plantings shall terminate on November 1. Groundcovers (3” pot) shall be installed by October 1 and Perennials (1 gal.) shall be installed by October 15.
3. Summer Planting: Planting performed between June 2 and August 31 shall be considered unseasonable and will require Owner’s approval.

E. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

F. Water: On-site sources of water will be provided by Owner. If an irrigation system is not present, the Contractor shall supply hoses, equipment, attachments and accessories for irrigation of planted areas.

G. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.
1. When planting trees, shrubs, and other plants within areas of existing turf or after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations. All restoration shall be seeded.

1.9 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:

a. In dying condition and have failed to flourish so that usefulness and appearance have been impaired; death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner, deicing compounds, removal by others, vandalism, or incidents that are beyond Contractor's control. It is the Contractor's responsibility to inspect the watering, cultivation and other maintenance operations performed by the Owner during the warranty period. Any methods or practices, which the Contractor considers unsatisfactory and not in accord with standard horticultural practices, shall be reported to the Owner in writing. The failure of the Contractor to so inspect or report shall be construed as acceptance of the Owner’s maintenance operations and shall not thereafter claim or assert that any defects which may develop are the result of such methods, practices or operations.

b. Structural failures including plantings falling or blowing over.

c. Faulty performance of tree stabilization.

d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Periods from Date of Substantial Completion:

a. Trees, Shrubs, Perennials, Ornamental Grasses, Ground Covers and Other Plants: 12 months.

3. Include the following remedial actions as a minimum:

a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.

b. Replace plants that are more than 25 percent dead, have an impaired appearance or in an unhealthy condition at end of warranty period.

c. A limit of one replacement of each plant will be required except for losses or replacements due to failure to comply with requirements.

d. Provide extended warranty for period equal to original warranty period, for replaced plant material.

e. Decisions of Owner for required replacements are final and binding upon Contractor.
1.10 MAINTENANCE SERVICE

A. Initial Maintenance Service for Trees, Shrubs, Perennials, Ground Covers, Ornamental Grasses and Other Plants: Provide maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than maintenance period below.

1. Maintenance Period: Until Substantial Completion. Owner assumes responsibility for plant maintenance upon substantial completion, except for resetting of settled plants, straightening of plants that are not plumb and tightening of tree guys. Contractor shall remove and dispose of tree wrap, stakes and guys at end of 12-month period.

B. Continuing Maintenance Proposal: From Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1.11 ACCEPTANCE

A. Preliminary Planting Acceptance:

1. Notify Owner at conclusion of planting operations to determine substantial completion by field inspection
2. Substantial completion requires:
   a. Plant material conforms to Contract Documents with respect to quality, quantity, size, species and location.
   b. Plant material shall be in healthy condition as defined under warranty.

B. Final Planting Acceptance:

1. Final planting acceptance shall be granted after completion of replacement operations required to fulfill guarantee.
2. On or about expiration of 12-month Warranty period, follow-up inspection will be made to determine replacements required to be made by Contractor in accordance with provisions of these specifications.
3. Upon completion of replacement program, Owner will inspect to determine acceptability of required replacements. If acceptable, owner shall notify Contractor of final acceptance of work.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List shown on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Select
plant material grown in the same USDA Hardiness Zone as the project site. Obtain Owner approval, prior to plant selection, for each species not grown in the same hardiness zone. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk (“included bark”); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots will be rejected.

2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.

B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Owner, with a proportionate increase in size of roots or balls. Use of such plants shall not result in increase in Contract price. Where plants larger than specified have been approved, Contractor shall assume responsibility for guarantee for plant in size as planted. Note that local municipality may require different heights of caliper measurement, such as “diameter at breast height” (dbh).

C. Tagging: Owner may review trees and shrubs at place of growth or at site before planting for compliance with requirements and for presence of diseases, injury or defects. Owner can reject unsatisfactory or defective material at any time during the progress of work. Rejected material shall be removed from the site.

D. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

E. Labeling: Label at least one plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant as shown on Drawings.

F. Substitutions: Owner must approve all substitutions. If material is not obtainable locally, submit written proof of nonavailability to the Owner, together with the proposal for equivalent materials for review.

G. If formal arrangements or consecutive order of plants is shown on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

H. Shade Trees: Balled and burlapped, single-stem with straight trunk, well-balanced crown and intact leader, of height and caliper indicated.

I. Ornamental Trees: Balled and burlapped, small, upright or spreading type, branched or pruned naturally according to species and type, and stem form as specified on Drawings.

J. Deciduous and Evergreen Shrubs: Provide balled and burlapped material unless specified otherwise.
K. Perennials, Ground Covers and Ornamental Grasses: Provide healthy, disease-free plants of species and variety shown or listed, with well-established root systems reaching to sides of container to maintain a firm ball, but not with excessive root growth encircling the container. Provide plants in removable containers or integral peat pots.

2.2 TOPSOIL

A. Topsoil: ASTM D 5268, pH range of 6 to 7, minimum 5 percent organic material content, fertile, friable, free of stones ½ inch or larger in any dimension, roots, plants, sod, clods, clay lumps, pockets of coarse sand, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials harmful to plant growth; free of obnoxious weeds and invasive plants including quackgrass, Johnsongrass, poison ivy, nutesedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass; not infested with nematodes; grubs; or other pests, pest eggs, or other undesirable organisms and disease-causing plant pathogens; friable and with sufficient structure to give good tilth and aeration. Continuous, air-filled pore space content on a volume/volume basis shall be at least 15 percent when moisture is present at field capacity.

B. Topsoil Source: Topsoil for landscape operations shall be obtained from the stripping of on-site topsoil, possibly supplemented with material imported from off-site. Verify suitability of soil to produce topsoil meeting requirements and amend. Supplement with imported topsoil when quantities are insufficient. Imported topsoil shall be obtained from a naturally, well-drained, arable site where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes.

2.3 INORGANIC SOIL AMENDMENTS

A. General: Based upon recommendations of the Topsoil Analysis, the following amendments may or may not be required. If required, the following specifications apply:

B. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Class: T, with a minimum of 99 percent passing through No. 8 sieve and a minimum of 75 percent passing through No. 60 sieve.
2. Provide lime in form of ground dolomitic limestone

C. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent sulfur, with a minimum of 99 percent passing through No. 6 sieve and a maximum of 10 percent passing through No. 40 sieve.

D. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

E. Aluminum Sulfate: Commercial grade, unadulterated.

F. Perlite: Horticultural perlite, soil amendment grade.
G. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 sieve.

H. Sand: Clean, washed, FA2 (Course Sand), and free of toxic materials.

I. Soil Conditioner: One Step Soil Conditioner, available from Midwest Trading (630) 365-1990 or equal as approved by Owner.

J. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.

K. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

2.4 ORGANIC SOIL AMENDMENTS

A. Mushroom Compost: Well-rotted cattle or stable manure with an admixture of 15-30% topsoil and shall have been used for the commercial growing of at least one crop of mushrooms.

B. Peat: Domestic peat composed of not less than 90% of decomposed organic matter by weight on oven-dried basis. Peat shall be delivered in a workable condition, with uniform texture and free from lumps.

C. Manure: 2 to 3 yrs. old, well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, debris, and material harmful to plant growth.

2.5 FERTILIZERS

A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 20 percent phosphoric acid.

B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, free flowing, conforming to state and federal laws, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. If utilized, fertilizer mix to remedy deficiencies found in soil tests.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.
2.6 PLANTING SOILS

A. Planting Soil: Mix soil amendments and fertilizers with topsoil at rates indicated below or in Topsoil Analysis recommendations. Apply fertilizer per manufacturer’s recommendations. Delay mixing fertilizer if planting does not follow placing of planting soil within a few days. Mixing of fertilizer shall only be required for turf areas as part of the initial installation and will only be required for individual trees and planting bed areas if the topsoil analysis indicates high nutrient deficiencies.

B. Soil used for backfilling planting pits and trenches shall be suitable topsoil. It shall be mixed as follows: 80% topsoil, 15% peat and 5% cattle manure. Mix planting soil before backfilling and stockpile at site.

C. For planting beds, mix planting soil either prior to planting or apply on surface of topsoil and mix thoroughly before planting.

2.7 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees, shrubs and plants, consisting of the following:

   1. Type: Hardwood, free of sticks and leaves and finely shredded.

2.8 PESTICIDES

A. General: Pesticide registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction. Contractor to maintain at job site all current pesticide applicator’s licenses, herbicide labels, and Material Safety Data Sheets (MSDS) for all chemicals utilized during the completion of the work.

B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

2.9 TREE STABILIZATION MATERIALS

A. Stakes and Guys: Refer to Installation Details on Landscape Plans for materials and methods of installation

   1. Guy Stakes: Rough-sawn, sound, new hardwood free of knots, holes, cross grain, and other defects, 2-by-4-inch nominal by length indicated, pointed at one end.

   2. Guys: 3/4" wide flat, woven, polypropylene (ArborTie or approved eq.)
2.10 MISCELLANEOUS PRODUCTS

A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer’s written instructions.

B. Trunk-Wrap Tape: First quality burlap or two layers of crinkled paper cemented together with bituminous material, 6 inches wide minimum, with stretch factor of 33 percent.

C. Erosion Control Materials: Biodegradable wood excelsior, straw or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer’s recommended biodegradable fasteners.

D. Mycorrhizal Fungi: Dry, granular inoculant containing at least 5300 spores per lb. of vesicular-arbuscular mycorrhizal fungi and 95 million spores per lb. of ectomycorrhizal fungi, 33 percent hydrogel, and a maximum of 5.5 percent inert material.

E. Slow Release Water Bags: “Treegator” 20 gal. capacity reinforced polyethylene slow-release watering bags or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.

2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.

3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.

4. Uniformly moisten excessively dry soil that is not workable, and which is too dusty.

B. Proceed with installation only after unsatisfactory conditions have been corrected. Starting work constitutes acceptance of conditions under which work is to be performed. After such acceptances, Contractor shall be responsible for correcting unsatisfactory and defective work resulting from such unsatisfactory conditions.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Owner and replace with new planting soil.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations. Existing plant materials that are to be
preserved shall be barricaded in a manner that will effectively protect them during construction operations.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Lay out individual tree, shrub, plants and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Owner’s acceptance of layout before excavating or planting. Make minor adjustments as required.

D. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.

1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.

E. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

3.3 PERENNIAL, ORNAMENTAL GRASS, GROUND COVER AREA ESTABLISHMENT

A. Loosen subgrade of planting areas to a minimum depth of 9 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Spread topsoil and, if required, apply soil amendments and fertilizer on surface. Thoroughly blend with planting soil.

   a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
   b. If required, mix lime with dry soil before mixing fertilizer.

2. Spread planting soil to a depth required to meet finish grades after natural settlement. Place approximately ½ the thickness of planting soil mixture required. Work into top of loosened subgrade to create a transition layer and then place remainder of planting soil mixture. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet. Incorporate 3 inches of mushroom compost into planting bed.

B. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

C. Before planting, obtain Owner's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate in strict accordance with installation details on the Landscape Plans. Excavations with vertical sides are not acceptable. Trim perimeter of bottom
leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.

1. Excavate approximately three times as wide as ball diameter for balled and burlapped trees. For hedge plantings, a continuous trench may be utilized instead of separate round pits.
2. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
3. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
4. Maintain supervision of excavations during working hours.
5. Keep excavations covered or otherwise protected when unattended by Installer's personnel.

B. Stockpile any acceptable topsoil encountered. Stockpiled topsoil shall be thoroughly pulverized before being returned to the pit and shall be mixed as referenced under Planting Soil Preparation section.

C. Legally dispose of subsoil removed from excavations off-site. Do not mix with planting soil or use as backfill.

D. Obstructions: Notify Owner if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations. Do not install plantings where depth of soil over underground construction or obstructions of rock is insufficient to accommodate roots or where pockets in rock or impervious soil require drainage.

1. Where such conditions are encountered in excavation planting areas and where stone, boulders or other obstruction cannot be broken or removed by hand methods and where trees would be planted under overhead wires, alternate locations for planting may be designated by the Owner.
2. Where locations cannot be changed as determined by the Owner, submit cost required to remove obstructions to depth of not less than 6 inches below required pit depth. Proceed with work after approval by Owner.

E. Drainage: Notify Owner if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits. No allowances will be made for lost plants due to improper drainage.

F. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.5 TREE AND SHRUB PLANTING

A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, carefully remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.

B. Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.
C. Set balled and burlapped stock plum b and in center of planting pit or trench with root flare 3”-6” above adjacent finish grades. Face plants to give best appearance or relationship to each other, to adjacent features and surrounding structures.

1. Use planting soil for backfill.
2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
5. Provide a 3” min. height saucer around pit for watering.

D. Set container-grown stock plum b and in center of planting pit or trench with root flare above adjacent finish grades.

1. Use planting soil for backfill.
2. Carefully remove root ball from container without damaging root ball or plant.
3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.

E. When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball. (2.5:1 max. slope). Prepare a saucer for watering around down slope of pit.

F. Wrap trees of 2-inch caliper and larger with trunk-wrap tape. Start at base of trunk and spiral cover trunk to height of first branches. Overlap wrap, exposing half the width, and securely attach without causing girdling. Inspect tree trunks for injury, improper pruning, and insect infestation and take corrective measures required before wrapping. Wrap newly planted trees prior to the occurrence of freezing temperatures in the fall. Wrap shall be removed the following spring after all threat of freezing temperatures has passed. Tie wrap securely in-place at top, bottom and 18 in. max. intervals with twine.

3.6 MECHANIZED TREE SPADE PLANTING

A. Trees may be planted with an approved mechanized tree spade at the designated locations. Do not use the tree spade to move trees larger than the maximum size allowed of similar field-grown, balled-and-burlapped root ball diameter according to ANSI Z60.1, or larger than the manufacturer’s maximum size recommendation for the tree spade being used, whichever is smaller.

B. When extracting the tree, center the trunk within the tree spade and move tree with a solid ball of earth.
C. Cut exposed roots cleanly during transplanting operations.

D. Use the same tree spade to excavate the planting hole as was used to extract and transport the tree.

E. Plant trees as shown on Drawings, following procedures in "Tree and Shrub Planting" article.

F. Where possible, orient the tree in the same direction as in its original location.

3.7 TREE AND SHRUB PRUNING

A. Remove only dead, dying, or injured branches and suckers. Prune to retain the natural character appropriate to the particular plant. Do not prune for shape.

B. Prune, thin, and shape trees and shrubs as directed by an Arborist and according to standard professional horticultural and arboricultural practices.

C. Do not cut tree leaders.

D. Do not apply pruning paint to wounds.

3.8 TREE STABILIZATION

A. If site conditions require, install trunk stabilization as follows unless otherwise indicated:

   1. Upright Staking and Tying: Stake deciduous and evergreen trees only as required to prevent wind tip out or if tree will not remain plumb. Use a minimum of two (2) stakes of length required to penetrate at least 18 inches below finish grade.

      a. Support trees with flat, woven polypropylene (ArborTie or approved eq.). Install per manufacturer's specifications. Allow enough slack to avoid rigid restraint of tree.

3.9 GROUND COVER, PERENNIAL AND ORNAMENTAL GRASS PLANTING

A. Set out and space ground cover, perennial and ornamental grass in even rows with triangular spacing as indicated.

B. Use planting soil for backfill.

C. Dig holes large enough to allow spreading of roots.

D. For rooted cutting plants supplied in flats, plant each in a manner that will minimally disturb the root system but to a depth not less than two nodes. If growing medium is comprised of 75 percent or more of peat, perlite, sand or material other than soil, pull visible roots away from the container medium so as to leave the roots partially exposed.

E. Slice or separate exterior roots on root-bound plants to promote growth.
F. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

G. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

H. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.10 PLANTING AREA MULCHING

A. Mulch backfilled surfaces of planting areas, pits, existing plantings beds and trees and other areas indicated.

1. Apply a 3-inch thickness of organic mulch for new and existing trees and shrubs and finish level with adjacent finish grades. Do not place mulch against trunks or stem.
2. Apply a 1-inch thickness of organic mulch for perennials, groundcovers and ornamental grasses.

3.11 PLANT MAINTENANCE

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, disease and insect control, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease.

B. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.12 PESTICIDE AND HERBICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Pre-Emergent Herbicides (Selective and Non-Selective): Apply to tree, shrub, and ground-cover areas in accordance with manufacturer's written recommendations. Do not apply to seeded areas.

C. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.
3.13 CLEANUP AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.

B. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

C. After installation and before Substantial Completion remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

3.14 DISPOSAL

A. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

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PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe and fittings.
2. Channel drainage systems.
3. Encasement for piping.
5. Cleanouts.
7. Expansion joints.
8. Catch basins.

1.2 ACTION SUBMITTALS

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

B. Shop Drawings:

1. Manholes: Include plans, elevations, sections, details, frames, and covers.
2. Catch basins and stormwater inlets.  Include plans, elevations, sections, details, frames, covers, and grates.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:  Show pipe sizes, locations, and elevations.  Show other piping in same trench and clearances from storm drainage system piping.  Indicate interface and spatial relationship between manholes, piping, and proximate structures.

B. Product Certificates:  For each type of cast-iron soil pipe and fitting, from manufacturer.

C. Field quality-control reports.

1.4 PROJECT CONDITIONS

A. Interruption of Existing Storm Drainage Service:  Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Architect and/or Construction Manager no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Architect and/or Construction Manager’s written permission.
PART 2 - PRODUCTS

2.1 PVC PIPE AND FITTINGS

A. PVC Sewer Piping:
   2. Fittings: ASTM F 949, PVC molded or fabricated, socket type.

2.2 CONCRETE PIPE AND FITTINGS

A. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76.
   1. Bell-and-spigot or tongue-and-groove ends and gasketed joints with ASTM C 443, rubber gaskets.
   2. Class III pipe unless noted otherwise.

2.3 NONPRESSURE TRANSITION COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:
   1. For Concrete Pipes: ASTM C 443, rubber.
   2. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
   3. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

2.4 CLEANOUTS

A. Plastic Cleanouts:
   1. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.5 MANHOLES

A. Standard Precast Concrete Manholes:
   1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
   2. Diameter: 48 inches minimum unless otherwise indicated.
   3. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
4. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.

5. Riser Sections: 4-inch minimum thickness, and lengths to provide depth indicated.

6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.

7. Joint Sealant: ASTM C 990, bitumen or butyl rubber.

8. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.

9. Steps: Individual FRP steps or FRP ladder wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.

10. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.

11. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch- minimum width flange and 26-inch- diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."

2. Material: ASTM A 536, Grade 60-40-18 ductile iron unless otherwise indicated.

2.6 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R, and the following:

1. Cement: ASTM C 150, Type II.


B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.


2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.

   a. Invert Slope: 0.10’ (1-1/4”) through manhole.
2. Benches: Concrete, sloped to drain into channel.
   a. Slope: 0.25’ (3’’)

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.
   2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

E. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.

F. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

2.7 CATCH BASINS

A. Standard Precast Concrete Catch Basins:
   1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
   2. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
   3. Riser Sections: 4-inch minimum thickness, 48-inch diameter, and lengths to provide depth indicated.
   4. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
   5. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
   6. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
   7. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch-diameter frame and grate.
   8. Steps: Individual FRP steps or FRP ladder wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of catch basin to finished grade is less than 60 inches.
   9. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.

B. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include flat grate with small square or short-slotted drainage openings.
   1. Size: 24 by 24 inches minimum unless otherwise indicated.
   2. Grate Free Area: Approximately 50 percent unless otherwise indicated.

C. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include 24-inch ID by 7- to 9-inch riser with 4-inch minimum width flange, and 26-inch-diameter flat grate with small square or short-slotted drainage openings.
   1. Grate Free Area: Approximately 50 percent unless otherwise indicated.
2.8 STORMWATER INLETS

A. Curb Inlets: Made with vertical curb opening of materials and dimensions according to utility standards.

B. Gutter Inlets: Made with horizontal gutter opening of materials and dimensions according to utility standards. Include heavy-duty frames and grates.

C. Combination Inlets: Made with vertical curb and horizontal gutter openings of materials and dimensions according to utility standards. Include heavy-duty frames and grates.

D. Frames and Grates: Heavy duty according to utility standards.

2.9 PIPE OUTLETS

A. Head Walls: Cast-in-place reinforced concrete, with apron and tapered sides.

B. Riprap Basins: Broken, irregularly sized and shaped, graded stone according to NSSGA's "Quarried Stone for Erosion and Sediment Control."


PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure drainage piping according to the following:

   1. Install piping pitched down in direction of flow.
   2. Install piping with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
   3. Install piping with 36-inch minimum cover.
   4. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
   5. Install nonreinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
   6. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping according to the following:
   1. Join PVC corrugated sewer piping according to ASTM D 2321 for elastomeric-seal joints.
   2. Join nonreinforced-concrete sewer piping according to ASTM C 14 and ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
   4. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.4 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Install piping so cleanouts open in direction of flow in sewer pipe.
   1. Use Heavy-Duty, top-loading classification cleanouts in all areas, Neenah R-1975 or equal.

B. Set cleanout frames and covers with cast-in-place-concrete block, 24 by 24 by 6 inches deep in lawn areas and 24 by 24 by 12 inches deep in paved areas. Set with tops 1” above grade in lawn areas and flush with surface in pavement areas.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.5 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 2 inches above finished surface elsewhere unless otherwise indicated.
3.6 CATCH BASIN INSTALLATION
A. Set frames and grates to elevations indicated.

3.7 STORMWATER INLET INSTALLATION
A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.
B. Construct riprap of broken stone, as indicated.
C. Install outlets that spill onto grade, anchored with concrete, where indicated.
D. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.
E. Construct energy dissipaters at outlets, as indicated.

3.8 CONCRETE PLACEMENT
A. Place cast-in-place concrete according to ACI 318.

3.9 CONNECTIONS
A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Section 221413 "Facility Storm Drainage Piping."
B. Make connections to existing piping and underground manholes.
   1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
   2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
   3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.
      a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
      b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
   4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.
3.10 IDENTIFICATION

A. Materials and their installation are specified in Section 312000 "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

1. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.11 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:
   a. Alignment: Less than full diameter of inside of pipe is visible between structures.
   b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
   c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
   d. Infiltration: Water leakage into piping.
   e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
   a. Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
   b. Option: Test plastic piping according to ASTM F 1417.
   c. Option: Test concrete piping according to ASTM C 924.

C.Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.
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