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<td>SITE WATER UTILITY DISTRIBUTION PIPING</td>
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<td>SITE SANITARY UTILITY SEWERAGE PIPING</td>
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<td>SUBDRAINAGE</td>
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</table>
SECTION 21 00 10 - FIRE SUPPRESSION GENERAL PROVISIONS

PART 1 - GENERAL

1.01 GENERAL

A. Refer to Division 00 - Procurement and Contracting Requirements and Division 01 - General Requirements, which all apply to work under this section.

1.02 DESCRIPTION OF WORK

A. This section applies to all work under the fire suppression contract. This shall include, but not necessarily be limited to, the following:

1. Water Based Fire Suppression Systems

B. The work shall include all materials, equipment and labor required for complete and properly functioning fire suppression systems.

C. Drawings for fire suppression work are in part diagrammatic, intended to convey the scope of work and indicate general arrangement of equipment, piping and approximate sizes and locations of equipment and materials.

D. Where job conditions require reasonable changes in indicated locations and arrangements, make such changes without additional cost to Owner.

E. Because of the scale of the drawings, certain piping or items such as unions or fittings may not be shown, but where such items are required by other sections of the specifications, or where they are required by the nature of the work, they shall be furnished and installed.

F. All elements of the construction shall be performed by workmen skilled in the particular craft involved, and regularly employed in that particular craft.

G. All work shall be performed in a neat, workmanlike manner in keeping with the highest standards of the craft.

1.03 CODES AND STANDARDS

A. All work shall be done in accordance with the applicable portion of the following codes and standards:

1. International Fire Suppression Code
2. International Plumbing Code
3. International Building Code
5. National Fire Protection Association Standards (NFPA)
6. Local Utility Company Requirements
7. Local Codes, all trades
8. Standards of ASME, ASHRAE, NEMA, IEEE, AGA, SMACNA
9. Occupational Safety and Health Administration (OSHA)
10. Underwriters Laboratories, Inc. (U.L.)
11. Iowa Administrative Codes
12. Americans With Disabilities Act (ADA)
B. Contractors shall familiarize themselves with all codes and standards applicable to their work and shall notify Design Professional of any discrepancies between the design and applicable code requirements so that any conflicts can be resolved. Where two or more codes or standards are in conflict, that requiring the highest order of workmanship shall take precedence, but such questions shall be referred to Design Professional for final decision.

C. Where drawings or specifications call for workmanship or materials in excess of code requirements, a lower grade of construction will not be permitted.

1.04 REQUIREMENTS & FEES OF REGULATORY AGENCIES

A. Contractor shall comply with the rules and regulations of the authorities having jurisdiction and local utility companies. Contractor shall check with each utility company providing service to this project and determine or verify their requirements regarding incoming services.

B. Secure all required permits and pay for all inspections, licenses and fees required in connection with the fire suppression work. Contractor shall post all bonds and obtain all licenses required by the State, City, County and Utility.

1.05 FIRE SUPPRESSION DRAWINGS

A. The fire suppression drawings indicate in general the building arrangement only, Contractor shall examine all construction drawings to familiarize himself with the specific type of building construction, i.e. type of structural system, floors, walls, ceilings, room finishes and elevations.

B. Drawings for piping are intended to convey the scope of the work and to indicate the general arrangement and locations of piping and equipment.

C. Contractor shall layout his own work and shall be responsible for determining the exact locations for equipment and rough-ins and the exact routing of piping so as to best fit the layout of the work.

D. Contractor shall take his own field measurements for verifying locations and dimensions: scaling of the drawings will not be sufficient for laying out the work.

E. Because of the scale of the drawings, certain basic items such as pipe fittings and valves may not be shown, but where such items are required by code or by other sections of the specifications, such items shall be furnished and installed.

1.06 SITE INSPECTION

A. Contractor shall inspect the site prior to submitting bid for work to familiarize himself with the conditions of the site which will affect his work and shall verify points of connection with utilities, routing of outside piping to include required clearances from any existing structures, trees or other obstacles.

B. Extra payment will not be allowed for changes in the work required because of the contractor's failure to make this inspection.

1.07 COORDINATION AND COOPERATION

A. It shall be Contractor's responsibility to schedule and coordinate his work with the schedule of General Contractor so as to progress the work expeditiously, and to avoid unnecessary delays.
B. Contractor shall fully examine the drawings and specifications for other trades and shall coordinate the installation of his work with the work of the other contractors. Contractor shall consult and cooperate with the other contractors for determining space requirements and for determining that adequate clearance is allowed with respect to his equipment, other equipment and the building. Design Professional reserves the right to determine space priority of the contractors in the event of interference between piping, conduit, ducts and equipment of the various contractors.

C. Drawings and specifications are intended to be complimentary. Any work shown in either of them, whether in the other or not, shall be executed according to the true intent and meaning thereof, the same as if set forth in all. Conflicts between the drawings and the specifications, or between the requirements set forth for the various contractors, shall be called to the attention of the Design Professional. If clarification is not asked for prior to the taking of bids, it will be assumed that none is required and that Contractor is in agreement with the drawings and specifications as issued. If clarification is required after the contract is awarded, such clarification will be made by the Design Professional and his decision will be final.

D. Special care shall be taken for protection for all equipment. All equipment and material shall be completely protected from weather elements, painting and plaster until the project is substantially completed. Damage from rust, paint and scratches shall be repaired as required to restore equipment to original condition.

E. Protection of all equipment during the painting of the building shall be the responsibility of the painting contractor, but this shall not relieve Contractor of the responsibility for checking to assure that adequate protection is being provided.

F. Where the final installation or connection of equipment in the building requires Contractor to work in finished areas of the building, Contractor shall be responsible that such areas are protected and are not marred, soiled or otherwise damaged during the course of such work. Contractor shall arrange with General Contractor for patching and refinishing of such areas which may be damaged in this respect.

1.08 OPENINGS, CUTTING AND PATCHING

A. Refer to Division 1 for additional cutting and patching information.

B. Piping and sleeves passing through all fire or smoke rated floors, roofs, walls, and partitions shall be provided with firestopping. Space between wall/floor and pipe or sleeve shall be sealed with UL listed intumescent fire barrier material equivalent to rating of wall/floor. Where piping and sleeves pass through floors, roofs, walls and partitions that are not fire or smoke rated, penetrations shall be sealed with grout or caulk.

C. New structure:

1. Contractor will coordinate the placing of openings and lintels in the new structure as required for the installation of the fire suppression work with the General Contractor.
2. Contractor shall furnish to General Contractor the accurate locations and sizes for required openings, but this shall not relieve Contractor of the responsibility of checking to assure that proper size openings are provided. When additional cutting and patching is required due to Contractor's failure to coordinate this work, Contractor shall make arrangements for the cutting, patching, and painting required.
1.09 EXCAVATING AND BACKFILLING

A. Contractor shall do all excavating necessary for fire suppression work and shall backfill trenches and excavations after work has been inspected. Care shall be taken in excavating that walls and footings and adjacent load bearing soils are not disturbed in any way, except where lines must cross under a wall footing. Where a line must pass under a footing, the crossing shall be made by the smallest possible trench to accommodate the pipe. Excavation shall be kept free from water by pumping if necessary.

B. Backfill about the structure shall be placed, when practical, as the work of construction progresses. Backfilling on or against concrete work shall be done only when directed. Backfilling of trenches shall progress as rapidly as the testing and acceptance of the finished sections of the work will permit. Backfill shall be in accordance with Division 31 Specifications.

1.10 MATERIALS AND EQUIPMENT

A. All materials and equipment shall be the standard product of a reputable U.S.A. manufacturer regularly engaged in the manufacture of the specified item. Where two or more units are required of the same item, they shall be furnished by the same manufacturer except where specified otherwise.

B. All material and equipment shall be installed in strict accordance with the manufacturer's recommendations.

C. The equipment specifications cannot deal individually with any minute items such as parts, controls, devices, etc., which may be required to produce the equipment performance and function as specified, or as required to meet the equipment guarantees. Such items, when required, shall be furnished as part of the equipment, whether or not specifically called for.

1.11 SUBMITTALS

A. Contractor shall furnish to Design Professional, complete sets of shop drawings and other submittal data. Contractor shall review and sign shop drawings before submittal. Refer to Division 01 specifications for additional requirements.

B. Shop drawings shall be bound into sets and cover related items for a complete system as much as practical and shall be identified with symbols or "plan marks" used on drawings. Incomplete, piecemeal or unbound submittals will be rejected.

C. Submittals required by the various sections of the Project Manual include, but are not necessarily limited to those identified in the submittal schedule below.

D. After award of contract, Contractor shall provide a completed submittal schedule including dates that the submittals will be to Design Professional for review.

E. Submit required information on the following items:

<table>
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<tr>
<th>SPEC SECTION</th>
<th>EQUIPMENT</th>
<th>DETAIL DWGS</th>
<th>PROD DATA</th>
<th>SAMPLES</th>
<th>INSTALL METHODS</th>
<th>O &amp; M MANUAL</th>
<th>CERTIFICATE OF DEMONSTRATION</th>
<th>OTHER (SEE NOTES)</th>
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<tr>
<td>21 10 00</td>
<td>Water Based Fire Suppression System</td>
<td>X</td>
<td>X</td>
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<td>X</td>
<td>X</td>
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<td>1, 2</td>
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Notes:
1. Hydraulic calculations.
2. All certifications and test results required by NFPA.
F. Design Professional will review shop drawings solely to assist contractors in correctly interpreting the plans and specifications.

G. Contract requirements cannot be changed by shop drawings which differ from contract drawings and specifications.

1.12 OPERATION AND MAINTENANCE MANUALS

A. Operation and maintenance manuals shall be submitted to Design Professional in duplicate upon completion of the job. Refer to Division 01 specifications for additional information.

B. Submit manuals in duplicate upon completion of the job. Manuals shall be bound in a three ring hard-backed binder. Front cover and spine of each binder shall have the following lettering done:

OPERATION
AND
MAINTENANCE
MANUAL
FOR
FIRE SUPPRESSION SYSTEMS

(PROJECT NAME)
(LOCATION)
(DATE)

SUBMITTED BY
(NAME AND ADDRESS OF CONTRACTOR)

C. Provide a master index at the beginning of manual showing items included. Use plastic tab indexes for sections of manual. Each section shall contain the following information for equipment furnished under this contract:

1. Equipment and system warranties and guarantees.
2. Installation instructions.
3. Operating instructions.
5. Spare parts identification and ordering list.
6. Local service organization, address, contract and phone number.
7. Shop drawings with reviewed stamp of Design Professional and Contractor shall be included, if applicable, along with the items listed above.
8. Reports of all tests and demonstrations including certificate of owner instruction, testing and balancing report, etc.

1.13 TRAINING AND DEMONSTRATIONS

A. Prior to acceptance of the fire suppression installation, Contractor shall provide to Owner, or his designated representatives, all comprehensive training on essential features and functions of all systems installed, and shall instruct Owner in the proper operation and maintenance of such systems.

1. Provide adequate notice to Owner as to when instruction will be conducted so appropriate personnel can be present.
2. Prepare the instruction format for a minimum of four Owner Representatives.
B. Equipment training:

1. Manufacturer's representatives shall provide instruction on each major piece of equipment. Contractor shall provide instruction on all other equipment.

2. Training sessions shall use the printed installation, operation and maintenance instruction materials included in the O&M manuals and emphasize preventative maintenance and safe operating procedures.

3. Training shall be performed by qualified factory trained technicians.

4. Contractor shall attend all sessions performed by the manufacturer's representative and shall add to each session any special information relating to the details of installation of the equipment as it might impact the operation and maintenance.

5. Equipment training shall occur as soon as possible after start up of the equipment and shall include hands-on operation. Training shall be provided for equipment listed in the table below.

C. The following are minimum requirements for Owner instruction:

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<tr>
<th>Section</th>
<th>Description</th>
<th>Hours (Note 1)</th>
<th>Presented By</th>
<th>Others Present</th>
<th>Remarks</th>
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<tr>
<td>21 10 00</td>
<td>Water Based Fire Suppression System</td>
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<td>Contractor</td>
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1. Any unused hours shall be used at Owner's discretion during the first year of occupancy.

D. Contractor shall submit to Design Professional a certificate, signed by Owner stating the date, time and persons instructed and that the instruction has been completed to the Owner's satisfaction. An example of a certificate form is as follows:
CERTIFICATE OF SYSTEM DEMONSTRATION

This document is to certify that the contractor has demonstrated the hereafter listed systems to Owner's representatives in accordance with the Contract documents and that the instruction has been completed to the Owner's satisfaction.

A. Project:

B. System(s):

C. Contractor's representatives giving instruction and demonstration:

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D. Owner's representatives receiving instruction:

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<th>DATE</th>
<th>HOURS</th>
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E. Acknowledgement of demonstration:

Contractor's Representative: ____________________________

signature

date

Owner's Representative: ____________________________

signature

date
1.14 SUBSTITUTIONS

A. Refer to Divisions 00 and 01.

B. Where substitutions are approved, Contractor assumes all responsibility for physical dimensions and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of the substitution.

1.15 ACCEPTABLE MANUFACTURERS

A. In most cases, equipment specifications are based on a specific manufacturer's type, style, dimensional data, catalog number, etc. Listed with the base specification, either in the manual or on the plan schedules are acceptable manufacturers approved to bid products of equal quality. These manufacturers are encouraged to submit to Design Professional at least 8 days prior to the bid due date drawings and catalog numbers of products to be bid as equals.

B. Manufacturers who do not submit prior to bidding, run the risk of having the product rejected at time of shop drawing submittal. Extra costs associated with replacing the rejected product shall be the responsibility of the contractor and/or the manufacturer.

C. If Contractor chooses to use a manufacturer listed as an equal, it shall be his responsibility to assure that the manufacturer has complied with the requirements in 'A' above. Contractor shall assume all responsibility for physical dimensions (including accessibility for maintenance), operating characteristics, and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of using the alternate manufacturer.

D. Where a model or catalog number is provided, it may not be inclusive of all product requirements. Refer to additional requirements provided on the plans or in the specifications as required. Similarly, there may be additional requirements included in the model or catalog number that are not specifically stated. These requirements shall also be met.

1.16 GUARANTEE

A. The entire fire suppression system including all sub-systems shall be guaranteed against defect in materials and installation for a minimum of one year from substantial completion or beneficial occupancy whichever occurs earlier. Any malfunctions which occur within the guarantee period shall be promptly corrected without cost to the Owner. This guarantee shall not limit or void any manufacturer's express or implied warranties.

1.17 CHANGES IN THE WORK

A. A contract change order is a written order to Contractor signed by Owner and Contractor, issued after the execution of the contract, authorizing a change in the work or an adjustment in the contract sum or the contract time. The contract sum and the contract time may be changed only by contract change order.

B. Owner, without invalidating the contract, may order changes in the work within the general scope of the contract consisting of additions, deletions or other revisions, with the contract sum and the contract time being adjusted accordingly. All such changes in the work shall be authorized by contract change order and shall be performed under the applicable conditions of the contract documents.

C. The cost or credit to Owner resulting from a change in the work shall be determined by mutual acceptance of a lump sum properly itemized and supported by sufficient substantial data to permit evaluation. A change order in excess of $300.00 shall be submitted with each item listed individually with a material cost and labor unit extension. Overhead and profit, as mutually agreed upon between Owner and Contractor shall be added to material and labor cost figures.
D. It shall be the responsibility of Contractor before proceeding with any change to satisfy himself that the change has been properly authorized in behalf of Owner.

1.18 COMPLETION

A. Systems, at time of completion, shall be complete, efficiently operating, non-hazardous and ready for normal use by Owner.

B. Contractor shall clean up and remove from the site all debris, excess material and equipment left during the progress of this contract at job completion.

1.19 CLEANING

A. At the conclusion of the construction, the entire system of piping and equipment shall be cleaned internally.

B. All temporary labels, stickers, etc., shall be removed from all fixtures and equipment. Name plates, ratings, instruction plates, etc., shall not be obscured by paint, insulation, or placement of units.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 21 00 10
SECTION 21 05 00 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.01 GENERAL

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 21 00 10 - Fire Suppression General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. This section includes the following:

1. Sleeves
2. Escutcheons
3. Fire Stopping
4. Guards
5. Access Doors
6. Equipment Pads

PART 2 - PRODUCTS

2.01 SLEEVES

A. Sleeves passing through non-load bearing walls and partitions shall be galvanized sheet steel with lock seam joints of minimum gauges as follows:

1. For pipes 2-1/2" and smaller - 24 gauge
2. For pipes 3" to 6" - 22 gauge
3. For pipes over 6" - 20 gauge

B. Sleeves passing through load bearing walls, concrete beams, fireproof walls, foundations, footings and waterproof floors shall be Schedule 40 steel pipe or cast iron pipe.

C. Sleeves are not required in masonry walls which are core drilled or walls of drywall construction, except where partition is a firestop, smokestop, or side of air plenum.

D. Sleeves for insulated piping shall be of sufficient internal diameter to take pipe and insulation and to allow for free movement of pipe. Waterproof sleeves shall be of sufficient internal diameter to take pipe and waterproofing material.

E. In finished areas where pipes are exposed, sleeves shall be terminated flush with wall, partitions and ceilings, and shall extend 1/2" above finished floors. Extend sleeves 1" above finished floors in areas likely to entrap water and fill space between sleeves and pipe with graphite packing and caulking compound.

F. Sleeves passing through membrane waterproofing or lead safe shall be provided with flashing, furnished and installed by General Contractor, extending 12" beyond sleeve in all directions; flashing shall be secured and sealed to membrane or lead safe and shall be sealed to sleeve and caulked watertight. Sleeves passing through roof shall be installed in same manner except sleeves shall extend to 6" above roof.

G. For exterior walls below grade, sleeves shall be cast iron. Space between sleeve and pipe shall be sealed with modular rubber links tightened with bolts (Link-Seal or equal).
2.02 ESCUTCHEONS  
A. Provide chrome plated escutcheons at each sleeved opening into finished spaces. Escutcheons shall fit around pipe; outside diameter shall cover sleeve. Where sleeve extends above finished floor, escutcheon shall be high cap type and shall clear sleeve extension. Secure escutcheons or plates to sleeve with set screws or other approved devices.

2.03 FIRESTOPPING  
A. Piping and sleeves passing through all fire or smoke rated floors, roofs, walls, and partitions shall be provided with firestopping. Space between wall/floor, pipe, and sleeve, shall be sealed with UL Listed intumescent fire barrier material equivalent to rating of wall/floor.

2.04 ACCESS DOORS  
A. When Fire Suppression Contractor provides any equipment requiring periodic servicing which will be concealed by non-accessible architectural construction, HVAC Contractor shall provide a flush access door. The access door shall be equal to a Karp DSC-214M Universal access door for non-rated construction or KRP-150FR for fire rated construction. Other approved manufacturers include Nystrom, Acudor, and Access Panel Solutions, with model applicable to the specific construction involved.
B. Access doors in fire rated construction shall be fire rated and have U.L. label. Refer to Architectural/General Construction plans for fire ratings.
C. Construction  
   1. Door and trim shall be 13 gauge steel, frames shall be 16 gauge steel.
   2. Trim shall be of one piece construction.
   3. Finish shall be prime coat of rust inhibitive baked grey enamel.
   4. Hinges shall be concealed, offset, floating hinge.
   5. Locks shall be flush, screwdriver operated with stainless steel cam-and-studs.

PART 3 - EXECUTION

3.01 SLEEVES  
A. Install sleeves for all piping passing through floors, roof, walls, concrete beams and foundations as required by this section.

3.02 ESCUTCHEONS  
A. Install escutcheons for all pipes entering finished spaces.

3.03 GUARDS  
A. Where exposed insulated piping extends to floor, provide sheet metal guard around insulation to extend up from floor 48”. Guard to be galvanized sheet not less than 26 gauge.

3.04 ACCESS DOORS  
A. Install access doors per manufacturer’s recommendations.
3.05 CONCRETE EQUIPMENT PADS

A. Provide equipment housekeeping pads for all floor mounted equipment. Anchor equipment to concrete equipment pads according to equipment manufacturer’s recommendations.

1. Construct concrete bases of dimensions indicated or as required to be 4 inches larger in both directions than supported unit. Pads to be a minimum of 4” in height unless noted otherwise.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer’s setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts according to manufacturer’s recommendations and to elevations required for proper attachment to supported equipment.
6. Use 3000-psi compressive strength concrete with #3 rebar 12” O.C.

END OF SECTION 21 05 00
SECTION 21 05 53 - IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 21 00 10 - Fire Suppression General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Extent of fire suppression identification work required by this section is indicated on drawings and/or specified in other Division-21 sections.

B. Type of identification devices specified in this section include the following:
   1. Painted identification materials
   2. Plastic pipe markers
   3. Plastic tape
   4. Valve tags

C. Identification furnished as part of factory fabricated equipment, is specified as part of the equipment assembly in other Division-21 sections.

1.03 QUALITY ASSURANCE

A. ANSI Standards: Comply with ANSI A13.1 for lettering size, colors, and viewing angles of identification devices.

1.04 SUBMITTALS

A. Schedules: Submit valve schedule for fire suppression system, typewritten and reproduced on 8-1/2" x 11" bond paper. Tabulate valve number, system or zone (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in margin of schedule. In addition, furnish extra copies for Maintenance Manuals.

PART 2 - PRODUCTS

2.01 IDENTIFICATION MATERIALS

A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division-21 sections. Where more than one single type is specified for an application, selection is Installer's option, but provide single selection for each product category.

B. Painted Identification Materials:

   1. Stencils: Standard fiberboard stencils, prepared for required applications with letter sizes generally complying with recommendations of ANSI A13.1 for piping and similar applications, but not less than 3/4" high letters for access door signs and similar operational instructions.

   2. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray-can form and grade.
3. Identification Paint: Standard identification enamel of colors indicated, or, if not otherwise indicated for piping systems, comply with ANSI A13.1 for colors.

C. Plastic Pipe Markers:


2. Small Pipes: For external diameters not greater than 6" (including insulation if any), provide full-band pipe markers extending 360 degrees around pipe at each location, fastened by one of the following methods:
   a. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
   b. Adhesive lap joint in pipe marker overlap.
   c. Laminated or bonded application of pipe marker to pipe (or insulation).
   d. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4" wide full circle at both ends of pipe marker, tape lapped 1-1/2".

3. Large Pipes: For external diameters of 6" and larger (including insulation if any), provide either full-band or narrow strip-type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:
   a. Laminated or bonded application of pipe marker to pipe (or insulation).
   b. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2" wide; full circle at both ends of pipe marker, tape lapped 3".
   c. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.

4. Lettering: Manufacturer's standard pre-printed nomenclature which best describes piping system in each instance, as selected by Design Professional in cases of variance with names as shown or specified.

5. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as a separate unit of plastic.

D. Plastic Tape:

1. General: Manufacturer's standard color-coded pressure-sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.
   a. Width: Provide 1-1/2" wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6", 2 1/2" wide tape for larger pipes.
   b. Color: Comply with ANSI A13.1, except where another color selection is indicated.

E. Valve Tags:

1. Brass Valve Tags: Provide polished brass valve tags with stamp-engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 7/16" high, and with 3/16" hole for fastener. Tag thickness 0.040 inches.
   a. Provide 2" diameter tags, except as otherwise indicated.
   b. Fill tag engraving with black enamel.
2. Plastic Valve Tags: Provide red heavy plastic tag with 7/16" white embossed sequenced numbers.

3. Valve Tag Fasteners: Manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks or heat sealed braided copper wire of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

F. Name Plates:
   1. General: Provide manufacturer’s standard preprinted plastic, brass, or aluminum with stamped, engraved or embossed letters.
   2. Lettering:
      a. Large Equipment: 1 1/2" lettering as appropriate.
      b. Small Equipment: 3/4" lettering as appropriate.
   3. Attachments: Mounting holes and screws, pressure sensitive adhesive backing, or solid brass chain.

2.02 LETTERING AND GRAPHICS

A. General: Coordinate names, abbreviations and other designations used in fire suppression identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of fire suppression systems and equipment.

   1. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Fire Pump, Standpipe F12).

PART 3 - EXECUTION

3.01 APPLICATION AND INSTALLATION

A. General Installation Requirements:

   1. Coordination: Where identification is to be applied to surfaces which require painting or other covering or finish including valve tags, install identification after completion of covering and painting if any. Install identification prior to installation of acoustical ceilings and similar concealment.

B. Piping System Identification:

   1. General: Install pipe markers of one of the following types on all fire suppression piping, and include arrows to show normal direction of flow:

      a. Stenciled markers, including color-coded background band or rectangle, and contrasting lettering of black or white. Extend color band or rectangle 2" beyond ends of lettering.
      b. Plastic pipe markers, with application system as indicated under "Materials" in this section.
      c. Stenciled markers, black or white for best contrast, wherever continuous color-coded painting of piping is provided.
2. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.
   a. Near each valve and control device.
   b. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
   c. At access doors, manholes and similar access points which permit view of concealed piping.
   d. Near major equipment items and other points of origination and termination.
   e. Spaced intermittently at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment.
   f. On piping above removable acoustical ceilings.

C. Valve Identification:

   1. General: Provide valve tag on every valve, cock and control device in fire suppression piping system; exclude check valves. List each tagged valve in valve schedule for each piping system.

D. Equipment Identification:

   1. General: Provide equipment identification for all equipment including fire pumps, fire pump controllers, zone control valves, and specialty system valves where applicable (i.e. dry valve or preaction system).

   2. Labeling: All equipment shall be labeled as per construction document plan marks or as designated by Owner.

   3. Provide identification by means of nameplates or stenciled painting as appropriate.
      a. For equipment with factory furnished casing, identification shall be by adhesive fixed name plates.
      b. Field insulated items, such as heat exchangers may be identified by plastic pipe markers or stenciled lettering.

END OF SECTION 21 05 53
SECTION 21 10 00 – WATER-BASED FIRE SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 21 00 10 - Fire Suppression General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Extent of fire suppression work is indicated on drawings and schedules, and by requirements of this section.

B. Applications of fire suppression systems include the following:

1. Sprinkler systems.
2. Standpipe systems.

1.03 QUALITY ASSURANCE


B. UL Labeling: Provide fire sprinkler piping products which have been approved and labeled by Underwriters Laboratories.

C. Local Fire Marshal Regulations: Comply with governing regulations pertaining to fire sprinkler piping.

D. All fire suppression work shall be performed by a qualified sprinkler contractor with at least three years experience that has obtained current certification in the State of Iowa under the Fire Extinguishing System Contractor Certification program. During the installation, a minimum of one person with at least three years sprinkler experience shall be present.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's data for fire suppression systems, materials and products.

B. Piping Shop Drawing and Hydraulic Calculations: The Contractor shall prepare a complete set of detailed working drawings and hydraulic calculations showing all equipment, fire service lines, risers, piping and heads. These drawings and calculations shall be approved in writing or stamped approved by the authorities having jurisdiction. The Contractor is responsible for any fees associated with the review and approval of the fire suppression layout drawings, product data and hydraulic calculations by the State Fire Marshal’s office. Contractor is also responsible for completion of the required fire extinguishing system submittal form to the SFM. This form is available from the State at the following website: http://www.dps.state.ia.us/fm/building/forms.shtml.

C. Certificate of Installation: Submit certification upon completion of fire suppression piping work which indicates that work has been tested in accordance with ANSI/NFPA 13 (Factory Mutual) and also that system is operational, complete and has no defects. (Submit all documentation as required by Factory Mutual).
PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Automatic Sprinklers
   1. Reliable Sprinkler Corporation.
   2. Tyco.
   3. Viking Corp.

B. Backflow Preventers
   1. Watts
   2. Apollo Valves
   3. Febco
   4. Zurn Wilkins

C. Gate Valves
   1. NIBCO
   2. Powell
   3. Milwaukee
   4. Watts

D. Bronze Body Butterfly Valves
   1. NIBCO
   2. Milwaukee

E. Butterfly and Swing Check Valves
   1. Victaulic
   2. Gruvlok by Anvil International
   3. Kennedy
   4. Milwaukee
   5. NIBCO

F. Ball Valves
   1. Watts B-6000 Series
   2. Milwaukee BA-100/BA-150
   3. NIBCO T-580 Series
   4. Apollo 77C Series

G. Grooved Piping Systems
   1. Gruvlok by Anvil International
   2. Victaulic

H. Fire Department Connections
   1. Larsen’s Manufacturing Company
   2. Guardian Fire Protection Equipment
   3. Potter-Roemer
   4. Croker
I. Water Flow Indicators, Outdoor Alarm Bells, and Supervisory Switches

1. Potter-Roemer / Potter Electric
2. System Sensor

2.02 FIRE SUPPRESSION SPECIALTIES

A. General: Provide fire suppression specialties, UL listed, in accordance with the following listing. Provide sizes and types which mate and match piping and equipment connections.

1. Water Flow Indicators: Provide vane type water flow detectors.
2. Outdoor Alarm Bell: Provide electric alarm bell in accordance with NFPA 13. Coordinate installation with Electrical Contractor.
3. Supervisory Switches: Provide products recommended by manufacturer for use in service indicated.
4. Low Air Pressure Horn: Provide low air pressure horn as indicated.
5. Air Pressure Maintenance Device, Dry-Pipe System: Provide air pressure maintenance device for dry-pipe standpipe piping as recommended by the manufacturer.
6. Automatic Sprinklers:
   a. Provide automatic sprinklers of type indicated on drawings, and in accordance with the following listing. Provide fusible links for 165 degrees F (74 degrees C), ordinary temperature, except where intermediate or high temperature rated sprinklers are required per NFPA 13 or as indicated on the plans.
      1) Upright
      2) Concealed Pendent with Flat Cover Plate
      3) Pendant
      4) Standard Dry-Type Pendent
      5) Standard Dry-Type Upright
      6) Dry-Type Concealed Pendent with Flat Cover Plate
   b. Finish: Painted white for concealed pendent, cast brass for upright pendent, white for recessed pendent or provide finish as indicated on the plans.
7. Sprinkler Cabinet and Wrench: Furnish steel, baked red enameled, sprinkler box with capacity to store 10 sprinklers and wrench sized to sprinklers.

B. Fire Department Connection: Provide fire department connection with integral clappers, 175 psi rated working pressure, of size and end type indicated.

2.03 BACKFLOW PREVENTERS

A. Double Check Detector Assembly Backflow Preventer (at main sprinkler system supply): A double check detector assembly shall be installed at referenced cross connections to prevent the backflow of polluted water into the potable water supply. The cross connections shall be determined by local inspection authority for use where a high hazard situation does not exist. It shall be a complete assembly including four ball-type test cocks and two resilient seated OS&Y isolation valves with tamper switches. The bypass line shall be hydraulically sized to accurately measure low flow and shall consist of a meter, a small diameter double check assembly with test cocks and isolation valves. Watts Regulator Co. Series 709DCDA or 774DCDA. The device shall meet the requirements of ANSI/ASSE Standard 1048 and AWWA Standard C510-92 and be approved by the FCCCHR at USC. All components of the backflow preventer assembly shall meet the requirements for ANSI/NSF 372 Certification, Drinking Water System Components, Lead Content.
2.04 VALVES

A. Butterfly - 1/4" to 2" Milwaukee Butterball BB2 Series
B. Ball - 2" to 3" Victaulic Series 727
C. Butterfly - 4" to 8" Victaulic Series 705 (Normally Open Valves) or Series 707C (Normally Closed Valves)
D. Gate - 2-1/2" and larger, iron body O.S.&Y., Powell Fig. 1797
E. Check - 2-1/2" to 3", Central Model 90, 4" to 8" Victaulic Series 710

2.05 PIPE MATERIALS

<table>
<thead>
<tr>
<th>Material</th>
<th>Service</th>
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</thead>
<tbody>
<tr>
<td>A. Ductile iron pipe ANSI A21.5 ANSI/AWWA C151</td>
<td>Underground water service main, 4&quot; dia. and Larger.</td>
</tr>
<tr>
<td>B. Polyvinyl Chloride Pipe (PVC) DR18 ANSI/AWWA C900 or C905 With tracer wire</td>
<td>Underground water service main.</td>
</tr>
<tr>
<td>C. Black steel pipe, Schedule 40, ASTM A795</td>
<td>Wet systems.</td>
</tr>
<tr>
<td>D. Black steel pipe, Schedule 10, ASTM A795</td>
<td>Wet systems.</td>
</tr>
</tbody>
</table>

2.06 PIPE FITTINGS

A. Steel Pipe:

1. Threaded pipe (2" dia and smaller): Malleable iron fittings, 150 pound standard flat band water pattern.
2. Welded pipe (2 1/2" dia and larger): Standard radius weld fittings and weld neck or slip-on flanges, same material and strength as pipe.
3. Mechanical grooved and roll-groove steel piping system and fittings: may be used as approved by code for black steel, stainless steel and galvanized steel. All components shall be by one manufacturer. System installation shall be in accordance with the manufacturer's recommendations.

2.07 JOINTS

A. Steel Pipe:

1. Threaded pipe (2" dia and smaller): Make joints using Teflon tape applied to male threads only. Cut pipe square, cut threads clean, remove burrs and ream ends to full size of bore.
2. Welded pipe (2 1/2" dia and larger): Welding shall conform to welding section of ANSI-B31.3 "Code for Power Piping."
3. Mechanical grooved and roll-groove pipe couplings: Grooved couplings may be used as approved by code for black steel and galvanized steel piping. Gasket type to be used shall be appropriate for intended service. All components shall be by one manufacturer. System installation shall be in accordance with the manufacturer's recommendations.
2.08 NIPPLES AND UNIONS

A. All nipples shall conform to size, weight and strength of adjoining pipe. When length of unthreaded portion of nipple is less than 1-1/2”, use extra strong nipple; do not use close nipples.

B. For pipe 2" and smaller, use screwed unions, for pipe 2-1/2" and over use flanged unions. For steel pipe use black or galvanized malleable iron unions, to conform to pipe with ground joint. Cast iron flanged unions gasket type. For threaded brass pipe, use bronze ground joint unions with octagon ends.

C. Install unions in the following locations so that a minimum amount of pipe need be disassembled:
   1. Long runs, at intervals of 80 feet.
   2. In by-pass around equipment, valves, and controls.
   3. In connections to equipment.
   4. Where indicated on drawings.

PART 3 - EXECUTION

3.01 GENERAL

A. Contractor shall familiarize himself with the general construction, plumbing, heating, ventilating, and electrical work and to use the information to avoid conflicts in space allocation with the other trades. Do not place pipes over electrical equipment.

B. In the case of an interference occurring during construction, Contractor shall rework and reinstall piping and equipment in order to make space available for another contractor's equipment without additional cost to the Owner.

C. Contractor shall work closely with the ceiling system installers and install sprinkler head drops before ceiling tiles are installed, and return to job after or during ceiling tile installation for installation of sprinkler heads.

D. Heads shall be located in center of ceiling tiles or as directed by Design Professional.

3.02 FIRE SUPPRESSION SPECIALTIES

A. General: Install fire suppression specialties as indicated, and in accordance with ANSI/NFPA 13.

B. Provide wire guards for all exposed sprinkler heads installed in gymnasiums, below ductwork in mechanical rooms, in electrical rooms, in telecommunication rooms, and locations where heads are susceptible to mechanical damage (e.g. within seven feet of floor level).

3.03 BACKFLOW PREVENTERS

A. Install backflow preventers where required per local code and in accordance with manufacturer's recommendations. Backflow preventers to be installed accessible for testing, installing contractor shall provide testing by a certified backflow assembly tester at time of installation as required by Code.

3.04 VALVES

A. Install valves as indicated on the drawings and as specified herein. Install sectional valves in inlet piping at bottom of each riser and in loops as indicated. Locate valves for easy access and operation. Do not locate valves with stems below horizontal. Mount supervisory switches on each sectional valve.
B. Install valves in equipment rooms to provide easy access to valve. Each valve installed 8'-0" above the floor shall be provided with chain operator. Bottom of chain operator shall be 7'-0" above floor.

C. Check valves shall not be installed in vertical runs of piping unless they are specifically designed for vertical operation.

D. Normally Open (N.O.) or Normally Closed (N.C.) valves shall be provided as required for intended system operation. For all supervised valves, the off-normal signal shall be initiated during the first two revolutions of the hand wheel or during one-fifteenth of the travel distance of the valve control apparatus from its normal position.

3.05 PIPING

A. General: Comply with requirements of ANSI/NFPA 13 for installation of fire sprinkler piping products where indicated, in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that fire sprinkler piping complies with requirements and serves intended purposes.

B. Arrange and install piping approximately as indicated; straight, plumb, and as direct as possible; form right angles on parallel lines with building walls. Keep pipes close to walls and avoid interference with other mechanical items. Locate groups of pipes parallel to each other; space at a distance to permit access for servicing valves. Most piping to be run in concealed locations unless indicated exposed, or in equipment rooms. Locate piping to avoid ductwork.

C. Install horizontal piping as high as possible without sags or humps so that proper grades can be maintained for drainage. Install drain piping at low points of fire sprinkler piping.

D. Install valved hose connections of sizes indicated, or 3/4" size if not otherwise indicated, on sprinkler at ends of branch lines and cross mains at locations where indicated.

E. Install air vents at high points of sprinkler piping.

F. Hangers and supports: Comply with NFPA for hanger materials
   1. Install standpipe system piping according to NFPA 14.
   2. Install sprinkler system piping according to NFPA 13.

3.06 ADJUST AND CLEAN

A. Sprinkler Piping Flushing: Prior to connecting sprinkler risers for flushing, flush water feed mains, lead-in connections and control portions of sprinkler piping. After fire sprinkler piping installation has been completed and before piping is placed in service, flush entire sprinkler system, as required to remove foreign substances, under pressure as specified in ANSI/NFPA 13. Continue flushing until water is clear, and check to ensure that debris has not clogged sprinklers.

3.07 FIELD QUALITY CONTROL

A. Hydrostatic Testing: After flushing system, test fire sprinkler piping hydrostatically, for period of 2 hours, at not less than 200 psi or at 50 psi in excess of maximum static pressure when maximum static pressure is in excess of 150 psi. Check system for leakage of joints. Measure hydrostatic pressure at low point of each system or zone being tested.
B. Dry-Pipe Testing: Test dry-pipe hydrostatically except, in freezing conditions, test with air at pressures not less than 50 psi, for period of 2 hours. Check system for leakage. Leave differential dry-valve clappers open during test, to prevent damage.

C. Repair or replace piping system as required to eliminate leakage in accordance with ANSI/NFPA standards for "little or no leakage", and retest as specified to demonstrate compliance.

3.08 EXTRA STOCK

A. General: For each style and temperature range required, furnish additional sprinkler heads, amounting to 1 unit for every 100 installed units, but not less than 5 units of each.

END OF SECTION 21 10 00
SECTION 22 00 10 - PLUMBING GENERAL PROVISIONS

PART 1 - GENERAL

1.01 GENERAL

A. Refer to Division 00 - Procurement and Contracting Requirements and Division 01 - General Requirements, which all apply to work under this section.

1.02 DESCRIPTION OF WORK

A. This section applies to all work under the plumbing contract. This shall include, but not necessarily be limited to, the following:

1. Waste and Vent Systems
2. Hot and Cold Water Distribution System
3. Plumbing Fixtures
4. Water Heating Systems
5. Sanitary Sewer
6. Piping Insulation
7. Natural Gas System

B. The work shall include all materials, equipment and labor required for complete and properly functioning plumbing systems.

C. Drawings for plumbing work are in part diagrammatic, intended to convey the scope of work and indicate general arrangement of equipment, piping and approximate sizes and locations of equipment and materials.

D. Where job conditions require reasonable changes in indicated locations and arrangements, make such changes without additional cost to Owner.

E. Because of the scale of the drawings, certain piping or items such as unions or fittings may not be shown, but where such items are required by other sections of the specifications, or where they are required by the nature of the work, they shall be furnished and installed.

F. All elements of the construction shall be performed by workmen skilled in the particular craft involved, and regularly employed in that particular craft.

G. All work shall be performed in a neat, workmanlike manner in keeping with the highest standards of the craft.

1.03 CODES AND STANDARDS

A. All work shall be done in accordance with the applicable portion of the following codes and standards:

1. International Mechanical Code
2. International Plumbing Code
3. International Building Code
4. International Fire Code
5. National Electric Code (NEC)
7. Local Utility Company Requirements
8. Local Codes, all trades
9. Standards of ASME, ASHRAE, NEMA, IEEE, AGA, SMACNA
10. Occupational Safety and Health Administration (OSHA)
11. Underwriters Laboratories, Inc. (U.L.)
12. Iowa Administrative Codes
13. Americans With Disabilities Act (ADA)
14. ANSI/NSF 372

B. Contractors shall familiarize themselves with all codes and standards applicable to their work and shall notify Design Professional of any discrepancies between the design and applicable code requirements so that any conflicts can be resolved. Where two or more codes or standards are in conflict, that requiring the highest order of workmanship shall take precedence, but such questions shall be referred to Design Professional for final decision.

C. Where drawings or specifications call for workmanship or materials in excess of code requirements, a lower grade of construction will not be permitted.

1.04 REQUIREMENTS & FEES OF REGULATORY AGENCIES

A. Contractor shall comply with the rules and regulations of the authorities having jurisdiction and local utility companies. Contractor shall check with each utility company providing service to this project and determine or verify their requirements regarding incoming services.

B. Meters for incoming services shall be selected based on the project requirements. Any questions concerning this shall be referred to Design Professional prior to bidding. Contractor shall provide the appropriate meter and associated materials if not furnished by the utility company.

C. Secure all required permits and pay for all inspections, licenses and fees required in connection with the plumbing work. Contractor shall post all bonds and obtain all licenses required by the State, City, County and Utility.

D. Contractor shall make all arrangements with each utility company and pay all service charges associated with new service.

1.05 PLUMBING DRAWINGS

A. The plumbing drawings indicate in general the building arrangement only, Contractor shall examine construction drawings to familiarize himself with the specific type of building construction, i.e. type of structural system, floors, walls, ceilings, room finishes and elevations.

B. Drawings are intended to convey the scope of the work and to indicate the general arrangement and locations of piping and equipment.

C. Contractor shall layout his own work and shall be responsible for determining the exact locations for equipment and rough-ins and the exact routing of piping so as to best fit the layout of the work.

D. Contractor shall take his own field measurements for verifying locations and dimensions: scaling of the drawings will not be sufficient for laying out the work.

E. Because of the scale of the drawings, certain basic items such as pipe fittings and valves may not be shown, but where such items are required by code or by other sections of the specifications, such items shall be furnished and installed.

1.06 ACTIVE SERVICES

A. Contractor shall be responsible for verifying exact location of all existing services prior to beginning work in that area.
B. Existing active services, i.e., water, gas, sewer, electric, when encountered, shall be protected against damage. Do not prevent or disturb operation of active services which are to remain.

C. When active services are encountered which require relocation, Contractor shall make request to authorities with jurisdiction for determination of procedures.

D. Where existing services are to be abandoned, they shall be terminated in conformance with requirements of the authorities having jurisdiction.

1.07 SITE INSPECTION

A. Contractor shall inspect the site prior to submitting bid for work to familiarize himself with the conditions of the site which will affect his work and shall verify points of connection with utilities, routing of outside piping to include required clearances from any existing structures, trees or other obstacles.

B. Extra payment will not be allowed for changes in the work required because of Contractor's failure to make this inspection.

1.08 COORDINATION AND COOPERATION

A. It shall be Contractor's responsibility to schedule and coordinate his work with the schedule of the General Contractor so as to progress the work expeditiously, and to avoid unnecessary delays.

B. Contractor shall fully examine the drawings and specifications for other trades and shall coordinate the installation of his work with the work of the other contractors. Contractor shall consult and cooperate with the other contractors for determining space requirements and for determining that adequate clearance is allowed with respect to his equipment, other equipment and the building. Design Professional reserves the right to determine space priority of the contractors in the event of interference between piping, conduit, ducts and equipment of the various contractors.

C. Drawings and specifications are intended to be complimentary. Any work shown in either of them, whether in the other or not, shall be executed according to the true intent and meaning thereof, the same as if set forth in all. Conflicts between the drawings and the specifications or between the requirements set forth for the various contractors shall be called to the attention of Design Professional. If clarification is not asked for prior to the taking of bids, it will be assumed that none is required and that Contractor is in agreement with the drawings and specifications as issued. If clarification is required after the contract is awarded, such clarification will be made by Design Professional and his decision will be final.

D. Special care shall be taken for protection for all equipment. All equipment and material shall be completely protected from weather elements, painting and plaster until the project is substantially completed. Damage from rust, paint and scratches shall be repaired as required to restore equipment to original condition.

E. Protection of all equipment during the painting of the building shall be the responsibility of the Painting Contractor, but this shall not relieve Contractor of the responsibility for checking to assure that adequate protection is being provided.

F. Where the final installation or connection of equipment in the building requires Contractor to work in finished areas of the building, Contractor shall be responsible that such areas are protected and are not marred, soiled or otherwise damaged during the course of such work. Contractor shall arrange with the General Contractor for patching and refinishing of such areas which may be damaged in this respect.
1.09 OPENINGS, CUTTING AND PATCHING

A. Refer to Division 1 for additional cutting and patching information.

B. Piping and sleeves passing through all fire or smoke rated floors, roofs, walls, and partitions shall be provided with firestopping. Space between wall/floor and pipe and/or sleeve shall be sealed with UL listed intumescent fire barrier material equivalent to rating of wall/floor. Where piping and sleeves pass through floors, roofs, walls and partitions that are not fire or smoke rated, penetrations shall be sealed with grout or caulk.

C. New structure:

1. Contractor will coordinate the placing of openings and lintels in the new structure as required for the installation of the plumbing work with the General Contractor.
2. Contractor shall furnish to General Contractor the accurate locations and sizes for required openings, but this shall not relieve Contractor of the responsibility of checking to assure that proper size openings are provided. When additional cutting and patching is required due to Contractor's failure to coordinate this work, Contractor shall make arrangements for the cutting, patching, and painting required.

1.10 EXCAVATING AND BACKFILLING

A. Contractor shall do all excavating necessary for sanitary sewers, storm sewers, water piping, gas piping, etc., and shall backfill trenches and excavations after work has been inspected. Care shall be taken in excavating that walls and footings and adjacent load bearing soils are not disturbed in any way, except where lines must cross under a wall footing. Where a line must pass under a footing, the crossing shall be made by the smallest possible trench to accommodate the pipe. Excavation shall be kept free from water by pumping if necessary.

B. Backfill about the structure shall be placed, when practical, as the work of construction progresses. Backfilling on or against concrete work shall be done only when directed. Backfilling of trenches shall progress as rapidly as the testing and acceptance of the finished sections of the work will permit. Backfill shall be in accordance with Division 31 Specifications.

1.11 MATERIALS AND EQUIPMENT

A. All materials and equipment shall be the standard product of a reputable U.S.A. manufacturer regularly engaged in the manufacture of the specified item. Where two or more units are required of the same item, they shall be furnished by the same manufacturer except where specified otherwise.

B. All material and equipment shall be installed in strict accordance with the manufacturer's recommendations.

C. The equipment specifications cannot deal individually with any minute items such as parts, controls, devices, etc., which may be required to produce the equipment performance and function as specified, or as required to meet the equipment guarantees. Such items, when required, shall be furnished as part of the equipment, whether or not specifically called for.

1.12 SUBMITTALS

A. Contractor shall furnish, to Design Professional, complete sets of shop drawings and other submittal data. Contractor shall review and sign shop drawings before submittal. Refer to Division 01 specifications for additional requirements.
B. Shop drawings shall be bound into sets and cover related items for a complete system as much as practical and shall be identified with symbols or "plan marks" used on drawings. Incomplete, piecemeal or unbound submittals will be rejected.

C. Submittals required by the various sections of the Project Manual include, but are not necessarily limited to those identified in the submittal schedule below.

D. After award of contract, Contractor shall provide a completed submittal schedule including dates that the submittals will be to Design Professional for review.

E. Submit required information on the following items:

<table>
<thead>
<tr>
<th>SPEC SECTION</th>
<th>EQUIPMENT</th>
<th>DETAIL DWGS</th>
<th>PROD DATA</th>
<th>SAMPLES</th>
<th>INSTALL METHODS</th>
<th>O &amp; M MANUAL</th>
<th>CERTIFICATE OF SYSTEM DEMONSTRATION</th>
<th>OTHER (SEE NOTES)</th>
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<td>Expansion Fittings and Loops for Plumbing Piping</td>
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</tr>
<tr>
<td>22 07 00</td>
<td>Plumbing Insulation</td>
<td>X</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>22 11 16</td>
<td>Domestic Water Piping</td>
<td>X</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>22 11 23</td>
<td>Domestic Water Pumps</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22 13 16</td>
<td>Sanitary Waste and Vent Piping</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22 13 19</td>
<td>Sanitary Waste Piping Specialties</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22 14 13</td>
<td>Facility Storm Drainage Piping</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22 15 16</td>
<td>Facility Nature Gas and Compressed Air Piping</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22 34 00</td>
<td>Fuel-Fired Domestic Water Heaters</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22 40 00</td>
<td>Plumbing Fixtures</td>
<td>X</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>22 47 00</td>
<td>Drinking Fountains and Water Coolers</td>
<td>X</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

F. Design Professional will review shop drawings solely to assist contractors in correctly interpreting the plans and specifications.

G. Contract requirements cannot be changed by shop drawings which differ from contract drawings and specifications.
1.13 OPERATION AND MAINTENANCE MANUALS

A. Operation and maintenance manuals shall be submitted to Design Professional in duplicate upon completion of the job. Refer to Division 01 specifications for additional information.

B. Submit manuals in duplicate upon completion of the job. Manuals shall be bound in a three ring hard-backed binder. Front cover and spine of each binder shall have the following lettering done:

OPERATION
AND
MAINTENANCE
MANUAL
FOR
PLUMBING SYSTEMS

(PROJECT NAME)
(LOCATION)
(DATE)

SUBMITTED BY
(NAME AND ADDRESS OF CONTRACTOR)

C. Provide a master index at the beginning of manual showing items included. Use plastic tab indexes for sections of manual. Each section shall contain the following information for equipment furnished under this contract:

1. Equipment and system warranties and guarantees.
2. Installation instructions.
3. Operating instructions.
5. Spare parts identification and ordering list.
6. Local service organization, address, contract and phone number.
7. Shop drawings with reviewed stamp of Design Professional and Contractor shall be included, if applicable, along with the items listed above.
8. Reports of all tests and demonstrations including certificate of owner instruction, testing and balancing report, etc.

1.14 TESTS AND DEMONSTRATIONS

A. Tests Required: Piping shall be tested and proved tight under the following static pressures. Pressure shall be maintained for four (4) hours.

<table>
<thead>
<tr>
<th>System</th>
<th>Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic Water Piping Systems</td>
<td>Refer to Section 22 11 16 - Domestic Water Piping.</td>
</tr>
<tr>
<td>Soil, Waste, Storm Drainage Piping</td>
<td>10 feet waterhead or fill to top of vent outlet above roof.</td>
</tr>
<tr>
<td>Below Grade</td>
<td></td>
</tr>
<tr>
<td>Soil, Waste, Storm Drainage Piping</td>
<td>Fill piping with water to top of vent outlet above roof, or 10 feet waterhead.</td>
</tr>
<tr>
<td>Above Grade</td>
<td></td>
</tr>
<tr>
<td>Gas Piping</td>
<td>10 psi air pressure, liquid soap test around all joints.</td>
</tr>
</tbody>
</table>

TESTING NOTE: All rubber gasket joints for cast iron soil pipe and fittings should be properly restrained if test pressures exceed 10 feet of head.
B. All systems shall be tested by Contractor and placed in proper working order prior to demonstrating systems to Owner. Contractor shall submit a report to Design Professional citing dates, times, pressures, and results of all tests performed.

1.15 TRAINING AND DEMONSTRATIONS

A. Prior to acceptance of the plumbing installation, Contractor shall provide to Owner, or his designated representatives, all comprehensive training on essential features and functions of all systems installed, and shall instruct Owner in the proper operation and maintenance of such systems.

1. Provide adequate notice to Owner as to when instruction will be conducted so appropriate personnel can be present.
2. Prepare the instruction format for a minimum of four Owner Representatives.

B. Equipment training:

1. Manufacturer's representatives shall provide instruction on each major piece of equipment. Contractor shall provide instruction on all other equipment.
2. Training sessions shall use the printed installation, operation and maintenance instruction materials included in the O&M manuals and emphasize preventative maintenance and safe operating procedures.
3. Training shall be performed by qualified factory trained technicians.
4. Plumbing Contractor shall attend all sessions performed by the manufacturer's representative and shall add to each session any special information relating to the details of installation of the equipment as it might impact the operation and maintenance.
5. Equipment training shall occur as soon as possible after start up of the equipment and shall include hands-on operation. Training shall be provided for equipment listed in the table below.

C. System training:

1. These sessions shall include hands-on demonstrations of system wide start-up, operation in all possible modes, shut-down and emergency procedures.

D. The following are minimum requirements for Owner instruction:

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Hours (Note 1)</th>
<th>Presented By</th>
<th>Others Present</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>22 00 10</td>
<td>Plumbing System (Excluding Equipment)</td>
<td>8</td>
<td>Contractor</td>
<td></td>
<td>Note 2</td>
</tr>
<tr>
<td>22 34 00</td>
<td>Water Heaters</td>
<td>4</td>
<td>Manufacturer's Representative</td>
<td>Contractor</td>
<td></td>
</tr>
<tr>
<td>22 11 23</td>
<td>Plumbing Pumps</td>
<td>2</td>
<td>Manufacturer's Representative</td>
<td>Contractor</td>
<td></td>
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</tbody>
</table>

1. Any unused hours shall be used at Owner's discretion during the first year of occupancy.

2. System training shall include, but not be limited to, valve locations, system routing, and air/water flow patterns, system start-up/shut-down/emergency procedures.

E. Contractor shall submit to Design Professional a certificate, signed by Owner stating the date, time and persons instructed and that the instruction has been completed to Owner's satisfaction. An example of a certificate form is as follows:
CERTIFICATE OF SYSTEM DEMONSTRATION

This document is to certify that Contractor has demonstrated the hereafter listed systems to Owner's representatives in accordance with the Contract documents and that the instruction has been completed to Owner's satisfaction.

A. Project:

B. System(s):

C. Contractor's representatives giving instruction and demonstration:

<p>| Contractor: | ________________________________ |</p>
<table>
<thead>
<tr>
<th>NAMES</th>
<th>DATE</th>
<th>HOURS</th>
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</table>

D. Owner's representatives receiving instruction:

<p>| Owner: | ________________________________ |</p>
<table>
<thead>
<tr>
<th>NAMES</th>
<th>DATE</th>
<th>HOURS</th>
</tr>
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</table>

Acknowledgement of demonstration:

E. Contractor's Representative: ________________________________
   signature
   ________________________________
   date

Owner's Representative: ________________________________
   signature
   ________________________________
   date
1.16 SUBSTITUTIONS

A. Refer to Divisions 00 and 01.

B. Where substitutions are approved, Contractor assumes all responsibility for physical dimensions and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of the substitution.

1.17 ACCEPTABLE MANUFACTURERS

A. In most cases, equipment specifications are based on a specific manufacturer's type, style, dimensional data, catalog number, etc. Listed with the base specification, either in the manual or on the plan schedules are acceptable manufacturers approved to bid products of equal quality. These manufacturers are encouraged to submit to Design Professional at least 8 days prior to the bid due date drawings and catalog numbers of products to be bid as equals.

B. Manufacturers who do not submit prior to bidding, run the risk of having the product rejected at time of shop drawing submittal. Extra costs associated with replacing the rejected product shall be the responsibility of Contractor and/or the manufacturer.

C. If Contractor chooses to use a manufacturer listed as an equal, it shall be his responsibility to assure that the manufacturer has complied with the requirements in 'A' above. Contractor shall assume all responsibility for physical dimensions (including accessibility for maintenance), operating characteristics, and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of using the alternate manufacturer.

D. Where a model or catalog number is provided, it may not be inclusive of all product requirements. Refer to additional requirements provided on the plans or in the specifications as required. Similarly, there may be additional requirements included in the model or catalog number that are not specifically stated. These requirements shall also be met.

1.18 GUARANTEE

A. The entire plumbing system including all sub-systems shall be guaranteed against defect in materials and installation for a minimum of one year from substantial completion or beneficial occupancy whichever occurs earlier. Any malfunctions which occur within the guarantee period shall be promptly corrected without cost to Owner. This guarantee shall not limit or void any manufacturer's express or implied warranties.

1.19 COMPLETION

A. Systems, at time of completion, shall be complete, efficiently operating, non-hazardous and ready for normal use by Owner.

B. Contractor shall clean up and remove from the site all debris, excess material and equipment left during the progress of this contract at job completion.

1.20 CLEANING

A. At the conclusion of the construction, the entire system of piping and equipment shall be cleaned internally.

B. All temporary labels, stickers, etc., shall be removed from all fixtures and equipment. Name plates, ratings, instruction plates, etc., shall not be obscured by paint, insulation, or placement of units.
C. Before being placed in service, all domestic water distribution systems, including those for cold water and hot water shall be chlorinated as required per Section 22 11 16 - Domestic Water Piping.

1.21 ELECTRICAL WORK

A. Electrical work and equipment provided by Contractor shall include the following:

1. Starters and disconnects for motors of plumbing equipment, but only where specifically indicated to be furnished integrally with equipment.

2. Wiring from motors to disconnect switches or junction boxes for motors of plumbing equipment, but only where specifically indicated to be furnished integrally with equipment.

3. All control wiring in accordance with the requirements of Division 26.

B. Electrical Contractor shall provide all power wiring for plumbing equipment, including services for motors and equipment furnished by the plumbing contractor. Motor and equipment locations are shown on the electrical drawings.

C. Electrical Contractor shall make final connections for all motors and equipment furnished by the plumbing contractor.

D. Electrical Contractor shall furnish safety disconnects and starters for all motors and equipment furnished by the plumbing contractor (unless specifically indicated to be furnished integrally with the equipment), so as to make service complete to each item of equipment.

E. Contractor shall consult with Electrical Contractor prior to conduit rough-in and shall verify with him the exact locations for rough-ins, and the exact size and characteristics of the services required, and shall provide Electrical Contractor a schedule of electrical loads for the equipment furnished by him. These schedules will be used for sizing services, disconnects, fuses, starters and overload protection.

1.22 TEMPORARY UTILITIES

A. Refer to Division 01 for specific requirements concerning temporary utilities.

END OF SECTION 22 00 10
SECTION 22 05 00 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.01 GENERAL

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. This section includes the following:

1. Demolition
2. Sleeves
3. Escutcheons
4. Fire Stopping
5. Guards
6. Access Doors
7. Equipment Pads

PART 2 - PRODUCTS

2.01 SLEEVES

A. Sleeves passing through non-load bearing walls and partitions shall be galvanized sheet steel with lock seam joints of minimum gauges as follows:

1. For pipes 2-1/2" and smaller - 24 gauge
2. For pipes 3" to 6" - 22 gauge
3. For pipes over 6" - 20 gauge

B. Sleeves passing through load bearing walls, concrete beams, fireproof walls, foundations, footings and waterproof floors shall be Schedule 40 steel pipe or cast iron pipe.

C. Sleeves are not required in masonry walls which are core drilled or walls of drywall construction, except where partition is a firestop, smokestop, or side of air plenum.

D. Sleeves for insulated piping shall be of sufficient internal diameter to take pipe and insulation and to allow for free movement of pipe. Waterproof sleeves shall be of sufficient internal diameter to take pipe and waterproofing material.

E. In finished areas where pipes are exposed, sleeves shall be terminated flush with wall, partitions and ceilings, and shall extend 1/2" above finished floors. Extend sleeves 1" above finished floors in areas likely to entrap water and fill space between sleeves and pipe with graphite packing and caulking compound.

F. Sleeves passing through membrane waterproofing or lead safe shall be provided with flashing, furnished and installed by General Contractor, extending 12" beyond sleeve in all directions; flashing shall be secured and sealed to membrane or lead safe and shall be sealed to sleeve and caulked watertight. Sleeves passing through roof shall be installed in same manner except sleeves shall extend to 6" above roof.
G. For exterior walls below grade, sleeves shall be cast iron. Space between sleeve and pipe shall be sealed with modular rubber links tightened with bolts (Link-Seal or equal). Waterproofing of pipe penetrations in exterior walls shall be coordinated with waterproofing contractor.

2.02 ESCUTCHEONS

A. Provide chrome plated escutcheons at each sleeved opening into finished spaces. Escutcheons shall fit around insulation or around pipe when not insulated; outside diameter shall cover sleeve. Where sleeve extends above finished floor, escutcheon shall be high cap type and shall clear sleeve extension. Secure escutcheons or plates to sleeve but not to insulation with set screws or other approved devices.

2.03 FIRESTOPPING

A. Piping, sleeves and ducts passing through all fire or smoke rated floors, roofs, walls, and partitions shall be provided with firestopping. Space between wall/floor and pipe, sleeve, and/or duct shall be sealed with UL Listed intumescent fire barrier material equivalent to rating of wall/floor.

2.04 ACCESS DOORS

A. When Plumbing Contractor provides any equipment requiring periodic servicing which will be concealed by non-accessible architectural construction, Plumbing Contractor shall provide a flush access door. The access door shall be equal to a Karp DSC-214M Universal access door for non-rated construction or KRP-150FR for fire rated construction. Other approved manufacturers include Nystrom, Acudor, and Access Panel Solutions, with model applicable to the specific construction involved.

B. Access doors in fire rated construction shall be fire rated and have U.L. label. Refer to Architectural/General Construction plans for fire ratings.

C. Construction

1. Door and trim shall be 13 gauge steel, frames shall be 16 gauge steel.
2. Trim shall be of one piece construction.
3. Finish shall be prime coat of rust inhibitive baked grey enamel.
4. Hinges shall be concealed, offset, floating hinge.
5. Locks shall be flush, screwdriver operated with stainless steel cam-and-studs.

PART 3 - EXECUTION

3.01 SLEEVES

A. Install sleeves for all piping passing through floors, roof, walls, concrete beams and foundations as required by this section.

3.02 ESCUTCHEONS

A. Install escutcheons for all pipes entering finished spaces.

3.03 GUARDS

A. Where exposed insulated piping extends to floor, provide sheet metal guard around insulation to extend up from floor 48”. Guard to be galvanized sheet not less than 26 gauge.
3.04 ACCESS DOORS

A. Where install access doors per manufacturer’s recommendations.

3.05 CONCRETE EQUIPMENT PADS

A. Provide equipment housekeeping pads for all floor mounted equipment. Anchor equipment to concrete equipment pads according to equipment manufacturer’s recommendations.

1. Construct concrete bases of dimensions indicated or as required to be 4 inches larger in both directions than supported unit. Pads to be a minimum of 4” in height unless noted otherwise.

2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.

3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use supported equipment manufacturer’s setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

5. Install anchor bolts according to manufacturer’s recommendations and to elevations required for proper attachment to supported equipment.

6. Use 3000-psi compressive strength concrete with #3 rebar 12" O.C.

END OF SECTION 22 05 00
SECTION 22 05 13 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.01 GENERAL

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.03 SUBMITTALS

A. Submit for all motors provided.
B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
C. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.
D. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.

PART 2 - PRODUCTS

2.01 GENERAL

A. Comply with NEMA MG1 unless noted otherwise.
B. Constant Speed Motors: Minimum 1.15 service factor; rated at 40 deg. C. ambient temperature with 90 deg. C. temperature rise (Class B insulation).
C. Motors Used with Variable Frequency Controllers: Inverter duty rated, Class F insulation (minimum). Windings shall be copper magnet with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
D. Multiple speed motors: Multiple windings.
E. Motor Efficiency: Premium efficiency as defined in NEMA MG1.
F. Peak instantaneous current: Maximum 130% of full-load.
G. All motors shall be provided as required for motor orientation within equipment.
H. Horsepower ratings shall be adequate for operating the connected loads continuously in the prevailing ambient temperatures in areas where the motors are installed, without exceeding the NEMA standard temperature rises for the motor insulations.
I. Motor designs, as indicated by the NEMA code letters, shall be coordinated with the connected loads to assure adequate starting and running torques.

J. Motor Enclosures:
   1. Shall be the NEMA types shown on the drawings for the motors.
   2. Where the types of motor enclosures are not shown on the drawings, they shall be the NEMA types which are most suitable for the environmental conditions where the motors are being installed. Motors located outdoors to be totally enclosed weatherproof epoxy-sealed type.
   3. Thoroughly clean and paint the enclosures at the factory with manufacturer's prime coat and standard finish.

K. Additional requirements for specific motors, as indicated in other sections, shall also apply.

2.02 SINGLE PHASE POWER

A. Capacitor start motors starting torque shall be three times full load torque and starting current shall be less than five times full load current.

B. Pull-up Torque: Up to 350 percent of full load torque.

C. Breakdown Torque: Approximately 250 percent of full load torque.

D. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

E. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.

F. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.03 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Starting Torque: Between 1 and 1-1/2 times full load torque.

B. Starting Current: Six times full load current.

C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.


E. Insulation System: NEMA Class B or better.

F. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.

G. Motor Frames: NEMA Standard T-Frames of steel, aluminum or cast iron with end brackets of cast iron or aluminum with steel inserts.

H. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter.
I. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum AFBMA 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

PART 3 - EXECUTION (Not Used)

END OF SECTION 22 05 13
PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 21 00 10 - Plumbing General Provisions are applicable to work required of this Section.

1.02 DESCRIPTION OF WORK

A. Provide material, equipment, labor and supervision necessary to install expansion joints and pump connections as required by the drawings and this section.

B. Any expansion indicated per plans has been based on copper pipe. If Contractor should choose to use an alternate approved material, he shall be responsible for any resulting changes in expansion.

1.03 SUBMITTALS

A. Submit manufacturer's catalog cuts and schedules for all mechanical joints and pump connectors.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Expansion Compensation Products

1. Flexonics
2. Metraflex
3. Victaulic
4. Minnesota Flexible
5. Keflex
6. Twin City Hose
7. Tri-State Industries
8. Mason Industries

2.02 WATER MAINS

A. Mechanical Expansion Compensator for 2" diameter and smaller copper pipe: Externally pressurized, all bronze with either stainless steel or bronze bellows, brass or copper shroud and end fittings, internal guides and internal anti-torque device. 150 psi minimum design pressure. Metraflex Model HPMF.

B. Mechanical Expansion joint for 2-1/2" diameter and larger: Self equalizing, ring controlled bellows, stainless steel shroud and end fittings, internal guides and internal anti-torque device. 300 psi design temperature. Metraflex Model MC.

C. Mechanical Expansion Joints for Grooved Pipe: Typical installation shall be approved by submittal.

D. Pipe Guides: Pre-insulated alignment guides, Keflex series CP.
2.03 PUMP CONNECTORS

A. Pump Connectors to be braided type, corrugated hose with stainless steel, Metraflex Metra-Mini Series.
B. In grooved piping systems, provide flexible couplings for first three (3) joints on each side of pump.

PART 3 - EXECUTION

3.01 Provide for taking up expansion in hot water mains and risers by means of installing loops, bends and mechanical expansion joints.

3.02 Use swing or swivel joints for connections from mains to risers and from risers to coils and equipment connections. Cold spring pipe during installation at points of bends or offsets.

3.03 Install anchoring as required for controlling expansion. Structural members for anchoring shall be firmly embedded or fastened into building members and shall withstand force of pipe expansion without straining building structure.

3.04 Where expansion joints and/or loops are installed, piping shall be properly guided and anchored as recommended by expansion joint manufacturer.

3.05 Install pump connectors in suction and discharge lines for each base mounted pump. Pump connectors to be installed in straight line without offset.

END OF SECTION 22 05 16
SECTION 22 05 19 - METERS AND GAUGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED WORK
A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this Section.

1.02 DESCRIPTION OF WORK
A. Provide material, equipment, labor and supervision necessary to install meters and gauges as required by the drawings and this section.

1.03 SUBMITTALS
A. Submit manufacturer’s catalog cuts showing complete descriptive data.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS
A. Thermometers
   1. Weiss 9VU35 with lead free thermowell (Base Specification)
   2. Taylor
   3. Weksler
   4. U.S. Gauge
   5. Trerice

B. Gauges (For Water)
   1. Weiss Series 4CTS (Base Specification)
   2. Dwyer
   3. Taylor
   4. Weksler
   5. U.S. Gauge
   6. Trerice

2.02 THERMOMETERS
A. 9" "Adjust-Angle" industrial thermometer, complete with double thick glass front, red reading, separable socket and arranged so the unit can be set at any required angle front to back or left to right during or after installation. Range 30-180 deg. F for domestic hot water.

2.03 GAUGES
A. Weiss Series 4" liquid filled compound pressure-vacuum gauge with snubber, stainless steel case, white dial, 1/4" male NPT, lead free brass and solder connection. Range 30" vacuum to 100 lb. pressure for water. Note: For outside applications use silicon filled gauge.

PART 3 - EXECUTION

3.01 Install thermometers in discharge and return piping at water heaters and at other points as indicated on the drawings.
3.02 Install gauge for each pump, mounted on 1/4" galvanized steel pipe manifold connected to the suction and discharge of the pump, with the needle valves in the manifold on each side of the gauge, so that the gauge may be opened to either the suction or discharge pressure.

3.03 Install gauges at pressure reducing valves and at other points as indicated on drawings.

END OF SECTION 22 05 19
PART 1 - GENERAL

1.01 RELATED WORK
A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK
A. Provide material, equipment, labor and supervision necessary to install valves as required by the drawings and this section.

1.03 SUBMITTALS
A. Submittal data shall include physical dimensions, construction materials, and pressure and temperature ratings.

1.04 QUALITY ASSURANCE
A. ANSI/NSF 372 Certification: All potable water supply piping valves (excluding main gate valves greater than 2") shall meet the requirements of ANSI/NSF 372 Certification, Drinking Water System Components, Lead Content.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS
A. Gate Valves and Check Valves
   1. NIBCO
   2. Powell
   3. Milwaukee
   4. Watts
   5. Clow
B. Lugged Body Butterfly Valves
   1. NIBCO
   2. ABZ
   3. Milwaukee
   4. Watts
C. Ball Valves
   1. Watts LFB-6080/6081
   2. Milwaukee UPBA-400S/450S
   3. NIBCO T/S-585-66 LF
   4. Apollo 77CLF-140/240
D. Domestic Hot Water Recirculation Balancing Valves
   1. Taco
   2. Bell & Gossett
   3. Wheatley
4. Armstrong
5. Flow Design Inc. (Flow Set)
6. Griswold
7. NIBCO

E. Polypropylene and/or PVDF Ball Valves

1. R&G Sloan - PPRO-Seal
2. ASAHF
3. Enfield
4. ASAHI/American
5. NIBCO/Chemtrol S61TBV/S62TBV and/or S65TBV

F. All valves of same type shall be of the same manufacturer unless otherwise specified in this section or on the drawings.

G. Model numbers in valve schedule based on NIBCO, unless noted otherwise.

2.02 VALVE CONSTRUCTION

A. Gate valves shall have solid tapered wedge, except where otherwise specified. Valves on steam service 4" and larger shall have 1/2" (minimum) bypass valve and piping.

B. Check Valves: 2" and smaller, horizontal swing type with Teflon seat, bronze lead free body. 200 psi, CWP and 300 deg. F maximum temperature. 2-1/2" and larger, flanged silent check type.

C. Ball Valves 4" and smaller: Bronze two-piece with stainless steel ball, teflon seats and stuffing box ring, vinyl insulated lever handle.
   1. Full port for valves 2-1/2" and smaller.
   2. Standard port for valves 3" and larger.

D. Domestic hot water recirculation balancing valves: Bell & Gossett Model CB “Circuit Setter” or equal.
   1. Ball type valve with bronze body/brass ball construction, glass and carbon fitted TFE seat rings, extended readout ports with integral check valves and gasketed caps, drain port, calibrated nameplate and position indicator, memory stops, and NPT connectors, rated for 300 psig at 250°F.
   2. Valves to seal leak-tight at maximum rated working pressure.
   3. Valves to be selected for 5 ft. pressure drop at full open setting and design water flow.

E. Ball Butterfly Valves 3" and Larger: ASTM A536 ductile iron body with aluminum bronze disc, EPDM or BUNA N seat, 416 stainless steel stem with extended neck.

2.03 VALVE SCHEDULE

A. Furnish valves as per the following schedule:

<table>
<thead>
<tr>
<th>Service</th>
<th>Valve type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building domestic and industrial water, before and after meter</td>
<td>Gate - 2&quot; and larger, Clow – epoxy coated, resilient seated, full port OS&amp;Y</td>
</tr>
</tbody>
</table>
Domestic hot and cold water pressures up to 200 psi

Ball - 2-1/2" and smaller, Apollo 77C-LF
Ball - 3" and 4", Apollo 70-LF
Butterfly – 3" and larger, N200 235/245
Check - 2" and smaller, T/S413Y-LF
2-1/2" and larger, 910-LF

Domestic hot water recirculation valves
All sizes – Bell & Gossett Model CB circuit setter.

B. Valves installed on all systems with insulated piping shall be provided with valve handle extensions and/or extended neck design to facilitate installation of insulation and make handles operable without damage to the insulation.

PART 3 - EXECUTION

3.01 Install valves as indicated on the drawings and as called for in other sections.

3.02 Install valves in equipment rooms to provide easy access to valve. Each valve installed 8'-0" above the floor shall be provided with chain operator. Bottom of chain operator shall be 7'-0" above floor.

3.03 Check valves shall not be installed in vertical runs of piping unless they are specifically designed for vertical operation.

3.04 Gate valves shall be installed in horizontal pipes with the valve stem in the vertical up position. Rotate valve stem only as allowed by the manufacturer's installation instructions.

END OF SECTION 22 05 23
SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this Section.

1.02 DESCRIPTION OF WORK

A. Provide materials, equipment, labor and supervision necessary to install hangers, supports, anchors, guides and seals as required by the drawings and this section.

B. Types of supports, anchors and seals specified in this section include the following:

1. Horizontal-Piping Hangers and Supports.
2. Vertical-Piping Clamps.
3. Hanger-Rod Attachments.
5. Saddles and Shields.
7. Anchors.

1.03 QUALITY ASSURANCE

A. Code Compliance: Comply with applicable plumbing and mechanical codes pertaining to product materials and installation of supports, anchors and seals.

B. UL and FM Compliance: Provide products which are Underwriters Laboratories listed and Factory Mutual approved.

C. ANSI Compliance: All supports and parts shall conform to the latest requirements of the ANSI Code for Pressure Piping B31.1.0 except as supplemented or modified by the requirements of this specification.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, acceptable manufacturers are as follows, with catalog numbers based on Grinnell:

1. Anvil International
2. B-Line
3. Elcen
4. Unistrut Building Systems

B. Pipe support systems shall secure pipes in place, prevent pipe vibration, provide vertical adjustment for maintaining required grades, and provide for expansion and contraction.

C. Pipe hangers shall be capable of supporting the pipe in all conditions of operation. They shall allow free expansion and contraction of the piping, and prevent excessive stress resulting from transferred weight being induced into the pipe or connected equipment.
D. Wherever possible, pipe attachments for horizontal piping shall be pipe clamps.

E. Wherever possible, structural attachments shall be beam clamps.

F. All rigid hangers shall provide a means of vertical adjustment after erection.

G. Hanger rods shall be subject to tensile loading only. At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit swing.

H. Where horizontal piping movements are greater than 1/2 inch, or where the hanger rod angularity from the vertical is greater than 4 degrees from the cold to hot position of the pipe, the hanger pipe and structural attachments shall be offset in such manner that the rod is vertical in the hot position.

I. Hangers shall be designed so that they cannot become disengaged by movements of the supported pipe.

J. Where supports are attached to concrete or other structural members, care shall be taken to prevent damage or weakening of the structural members.

K. Where concrete inserts are used, it shall be the Contractor's responsibility to accurately locate and attach inserts to concrete forms.

L. Hangers and supports that are in direct contact with copper piping shall be copper plated or have nonmetallic coating for electrolytic protection.

PART 3 - EXECUTION

3.01 INSTALLATION - HORIZONTAL PIPE SUPPORT

A. Steel and stainless steel pipe shall be supported at a maximum span of 10 feet for all pipe sizes, with hanger rods sized accordingly for total supported weight.

B. Copper pipe shall be supported at a maximum length of 6 feet for pipe sizes up through 1-1/2” and at a maximum length of 10 feet for pipe sizes 2” and larger with hanger rods sized accordingly for the total supported weight.

C. PVC and CPVC pipe shall be supported at a maximum span of 3 feet for pipe sizes up through 1” and at a maximum span of 4 feet for pipe sizes 1-1/4” and larger with hanger rods sized accordingly for total supported weight.

D. PEX tubing and Polyethylene pipe shall be supported at a maximum span of 32” with hanger rods sized accordingly for the total supported weight.

E. Cast Iron soil pipe shall be supported with one hanger for each section of pipe (maximum 10’ span) with hanger rods sized accordingly for the total supported weight. Locate hangers within 18” of hub or joint.

F. In addition to the above specified spacings, install additional hangers at change in pipe direction and at concentrated loads, large valves, strainers, etc.

G. When two or more pipes are to be run parallel together, they may be supported on trapeze type hangers. Trapeze bar angles or channels and hanger rods shall be of sufficient size with required spacing to support the particular group of pipes.
H. For suspending hanger rods from brackets attached to walls; use welded steel brackets, Fig. 194 for loads up to 750 lbs; Fig. 195 for loads up to 1,500 lbs; Fig. 199 for loads up to 3000 lbs.

I. Where pipes are to be racked along walls, use malleable iron one-hole clamp, Fig. 126 for pipes up to 3". For pipes larger than 3", use steel channel strut pipe rack.

J. Where pipes are to be supported from floor, use unistrut pipe stand with post base. Unformed concrete will not be permitted.

3.02 INSTALLATION - VERTICAL PIPE SUPPORTS

A. Support vertical steel and copper pipe at every other floor line.

B. Support vertical cast iron soil pipe at every floor line.

C. In addition to the above, support vertical pipes at base of riser with base fitting set on concrete or block pier, or by hanger located on horizontal connection close to riser.

D. Where pipe sleeves extend above floor, place pipe clamps at ceiling below and support clamp extensions from inserts or other approved attachment.

3.03 PIPE ATTACHMENTS

A. For horizontal steel pipe, use adjustable carbon steel clevis, Fig. 260, for pipes up to 30".

B. For horizontal copper pipe and tube, use copper plated adjustable carbon steel clevis, Fig. CT-65.

C. When thermal expansion for horizontal pipe is in excess of 1/2" axially as indicated on the drawing, use adjustable steel yoke pipe roll, Fig. 181, or pipe roll stand, Fig. 177.

D. For glass piping, provide padded pipe clamps and padded hangers as per manufacturer’s recommendations.

3.04 INTERMEDIATE ATTACHMENTS

A. Hanger rods: use carbon steel single or double end threaded, Figs. 140 and 253 as required. Continuous threaded rod, Fig. 146, may be used wherever possible. Contractor may at his option cut and thread rod on the job site.

B. Chain, wire or perforated strap hangers will not be permitted. One pipe shall not be suspended from another pipe.

C. Hangers shall be supported from appropriate structural members. In no case shall hangers be supported from ductwork, cable trays, piping, or other equipment. Existing hangers and supports shall not be used as supports for new hangers unless specifically designed as such, or additional loadings have been confirmed to be acceptable for existing supports.

3.05 STRUCTURAL ATTACHMENTS

A. For attaching steel or copper plated hanger rods to reinforced concrete; use black carbon steel concrete inserts, Fig. 285 for loads up to 400 lbs., Fig. 281 for loads up to 1200 lbs. or suitable drilled inserts equal to Ramset/Red Head - Trubolt wedge anchor, Ramset/Red Head Epcon system or Hilti Kwik Bolt II anchor.
B. For attaching steel hanger rods to structural steel beams, use malleable iron C-clamps, Fig. 87, with retaining clip for loads up to 500 lbs.; Fig. 229 with extension piece for loads up to 1,365 lbs. For copper plated hanger rods, use copper plated malleable iron C-clamps, Fig. CT-88, with hardened cup point set screw, for loads up to 400 lbs.

C. For attaching steel hanger rods to wood structural members, use malleable iron ceiling flange pipe threaded, Fig. 128 for loads up to 480 lbs., Fig. 153 for loads up to 1270 lbs. For copper plated hanger rods, use copper plated malleable iron ceiling flange, Fig. CT-128R for loads up to 180 lbs.

D. Under no circumstances shall hangers be attached to metal roof deck.

3.06 PIPE COVERING PROTECTION

A. Hangers and supports for insulated cold piping shall not injure or pierce insulation. Provide insulation protection shields or saddles for piping, Fig. 160, 161, 162, 163, 164, 165, 165A, 166A, or 167 in conjunction with hanger or roll device.

3.07 ROOF MOUNTED PIPING AND EQUIPMENT

A. Roof mounted equipment, not specified to be mounted on roof curbs shall be installed on equipment mounting rails specifically designed for that purpose or as shown on plans.

B. Roof mounted piping shall be mounted on a pipe support system equal to B-Line C-Port.

END OF SECTION 22 05 29
SECTION 22 05 48 - VIBRATION CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Conditions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Extent of vibration isolation work required by this section is indicated on drawings and schedules, and/or specified in other Division-22 sections.

B. All plumbing equipment over one horsepower, unless otherwise noted shall be isolated from the structure by means of vibration and noise isolators.

C. Where isolator type and deflection are not shown, the related equipment shall be isolated in accordance with the 2011 ASHRAE Handbook - HVAC Applications, Chapter 48.

D. Types of vibration isolation products specified in this section include the following:
   1. Precompressed Molded Fiberglass Isolators.
   2. Elastomeric Isolators.
   5. Isolation Hangers.
   7. Concrete Inertia Bases.
   8. Isolation Rail Systems.

E. Vibration isolation products furnished as part of factory-fabricated equipment are specified as part of the equipment assembly in other Division-22 sections.

F. Refer to other sections of these specifications for equipment foundations, hangers, sealants, gaskets and other work related to vibration isolation work.

1.03 QUALITY ASSURANCE

A. Product Qualification: Provide each type of vibration isolation unit produced by specialized manufacturer, with not less than 5 years' successful experience in production of units similar to those required for project.

   1. The materials and systems specified in this Section shall all be provided by the Contractor, from a single vibration isolation materials manufacturer to assure single responsibility for the performance of all isolation materials.

1.04 SUBMITTALS

A. The isolator manufacturer's submittal shall include the complete design for required isolation and bases, and a tabulation of the design data including O.D., free and operating heights of the isolators.
PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Vibration Isolation Products

1. Kinetics Noise Control, Inc.
2. Vibration Eliminator Co., Inc.
3. Vibration Mountings and Controls, Inc.
4. Mason Industries

B. The following item specifications apply to the corresponding Type numbers used in the Vibration Isolation Schedule. Model types are based on the 2011 ASHRAE Handbook - HVAC Applications, Chapter 48.

2.02 ISOLATION MATERIALS AND SUPPORT UNITS

A. Springs: All springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. All springs except internal nested springs shall have an outside diameter not less than 0.8 of the compressed height of the spring. Ends of springs shall be square and ground for stability. Laterally stable springs shall have kx/ky ratios of at least 0.9. All springs shall be fully color-coded to indicate capacity – color striping is not considered adequate.

B. Corrosion Protection: All springs shall be powder-coated enamel. Housings shall be galvanized, powder-coated enamel, or painted with rust-resistant paint. Hot-dipped galvanized housings shall be provided as indicated on the Schedule.

C. Base Types

1. Type A Bases - no base required. Isolators may be attached directly to the supported equipment.
2. Type B Bases - Steel Equipment Bases: Bases shall be of welded construction with cross members to form an integral support platform. Structural steel members shall be designed to match supported equipment.
3. Vibration bases for fans shall have adjustable motor slide rails as indicated on their Schedule, and shall accommodate motor overhang.
4. Bases for exterior use shall be painted or hot-dipped galvanized for complete corrosion resistance.
5. Minimum clearance under steel equipment bases shall be 25mm (1”).
6. Type C Bases - Concrete Inertia Bases: Inertia bases shall be of welded steel construction with concrete in-fill supplied by the installing contractor on site and shall incorporate reinforcing bars, spaced 300 mm (12”) maximum on centers each way.
7. Inertia bases for pumps shall be of sufficient size to accommodate supports for pipe elbows at pump suction and discharge connections (if this information has been provided for configuration).
8. Inertia bases for fans shall include motor slide rails as indicated on their Schedule.
9. The weight of each inertia base shall be at least (1.5 times(x)) to the weight of the equipment mounted thereon or sufficient to lower the center of gravity to or below the isolator support plane.
10. Inertia bases shall be a minimum of 150 mm (6”) thick.
11. Type D Bases: Isolation Rail System, consisting of two parallel aluminum rail systems with continuous neoprene air and water seal, incorporating steel spring isolators designed for one inch static deflection, all fabricated to be installed over the roof curb system, and provide continuous support for the isolated equipment.
D. Isolator Types

1. Type 1 Isolator - Rubber Pads and Glass Fiber Pads:
   a. Isolation pads shall be single ribbed or crossed, double ribbed elastomer-in-shear pads, in combination with steel shims when required, having minimum static deflections as tabulated. All pads shall be true elastomer-in-shear using alternately higher and lower ribs to provide effective vibration isolation, and shall be molded using 2500 PSI (176 kg/cm²) tensile strength, oil resistant compounds with no color additives. Pads shall be 45 to 65 durometer and designed to permit 60 or 120 PSI (4.2 or 8.4 kg/cm²) loading at maximum rated deflections. When two isolation pads are laminated, they shall be separated by, and bonded to, a galvanized steel shim plate. Neoprene vibration isolators shall have minimum operating static deflections as shown on the Vibration Isolation Schedule or as indicated on the project bid documents, not exceeding published load capabilities.
   b. Fiberglass continuous support material shall be high-density matrix of compressed molded fiberglass; individually coated with a flexible, moisture-impervious elastomeric membrane, designed to allow controlled air movement in the fiber media. It shall be manufactured in such a way that the pumping action of air between fibers provides viscous damping, reducing motion caused by transient shock and vibration. The material shall be non-corrosive, non-combustible, non-absorbent, and resists rust, ozone, mildew and fungus, vermin proof and it shall not shrink, swell, or decompose. Isolation characteristics of the media shall be constant over a temperature range of -40°F to 250°F (40°C to 121°C).

2. Type 2 Isolators - Rubber Mounts and Hangers:
   a. Vibration isolators shall be neoprene, molded from oil-resistant compounds, with cast-in-top steel load transfer plate for bolting to supported equipment, and a bolt-down plate with holes provided for anchoring to supporting structure. Top and bottom surfaces shall have non-skid ribs. Neoprene vibration isolators shall have minimum operating static deflections as shown on the Vibration Isolation Schedule or as indicated on the project documents but not exceeding published load capabilities.
   b. Vibration isolators with maximum static deflection requirements under the operating load conditions not exceeding .40” shall be hangers consisting of an elastomer-in-shear insert encased in a welded steel bracket and provided with a stamped load transfer cap. The elastomer insert shall be neoprene, molded from oil resistant compounds and shall be color coded to indicate load capacity and selected to operate within its published load range. The hanger bracket shall be designed to carry a 500% overload without failure and to allow a support rod misalignment through a 30-degree arc without metal-to-metal contact or other short circuit.
3. Type 3 Isolators - Spring Isolators and Hangers:

   a. Vibration isolators shall be free standing, un-housed, laterally stable springs wound from high strength spring steel. Springs shall have a lateral stiffness greater than 0.8 times the rated vertical stiffness and shall be designed to provide up to 50% overload capacity. Springs shall be supported either with a neoprene cup or a metal base plate complete with a ribbed neoprene pad, minimum 6 mm (0.25”) thick, bonded to the base plate. Springs shall be selected to provide operating static deflections as required. Springs shall be color coded or otherwise identified to indicate load capacity. In capacities up to 5,000 lbs., springs shall be replaceable. In capacities over 5,000 lbs., springs shall be welded to the top and bottom load plate assemblies. Springs shall be assembled between a top and bottom steel load plate. The upper load plate shall be provided with a steel leveling bolt lock nut and washer for attachment to the supported equipment. The lower load plate shall have a non-skid noise isolation pad bonded to the bottom and have provisions for bolting the isolator to the supporting structure.

   b. Vibration isolators for suspended equipment, with minimum static deflection requirement exceeding .4”, shall be hangers consisting of a free-standing, laterally stable steel spring and elastomeric washer in series, assembled in a stamped or welded steel bracket. The spring element shall meet all the specified characteristics described in above. The stamped or welded hanger bracket shall meet all the specified characteristics described above. Shall also be fitted with a self-centering load cap for the hanger rod.

4. Type 4 Isolators - Restrained Spring Isolators: Vibration isolators for equipment which is subject to load variations and large external or torquing forces shall consist of large diameter laterally stable steel springs assembled into formed or welded steel housing assemblies designed to limit vertical movement of the supported equipment. Springs shall be supported either with a neoprene cup of a metal base plate complete with a ribbed neoprene pad, minimum 6 mm (0.25”) thick, bonded to the base plate. Housing assembly shall be formed or fabricated steel members and shall consist of a top-load plate complete with adjusting and leveling bolts, vertical restraints, isolation washers and a bottom plate with non-skid noise stop pads and holes provided for anchoring to supporting structure. Housing shall be hot dipped galvanized. Spring elements shall meet all the specified characteristics described above.

5. Type 5 Isolators - Thrust Restraints: Provide in pairs. Locate on centerline of fan if possible. Bridge the flexible duct connector. Spring elements shall meet all the specified characteristics described above.

E. Flexible Piping Connectors:

1. Piping over one inch diameter and piping three supports away from rotating or reciprocating HVAC equipment shall be isolated from the structure by means of vibration and noise isolators.

2. Suspended piping shall be isolated with Type 2 Hangers described herein.

3. Floor mounted piping shall be isolated with Type 2 Isolators (spring mounts) described herein.

4. Flexible members shall be incorporated in the piping adjacent to all reciprocating and/or rotating equipment and pumps. Flexible pipe connectors not required at in-line pump installations.

5. See Section 22 05 16 - Expansion Fittings and Loops for HVAC Piping for pump connector specifications.
PART 3 - EXECUTION

3.01 PERFORMANCE OF ISOLATORS

A. General: Comply with minimum static deflections recommended by the American Society of Heating, Refrigerating and Air-Conditioning Engineers, including definitions of critical and noncritical locations, for selection and application of vibration isolation materials and units as indicated.

B. Manufacturer's Recommendations: Except as otherwise indicated, comply with manufacturer's recommendations for selection and application of vibration isolation materials and units.

3.02 APPLICATIONS

A. General: Apply types of vibration isolation materials and units indicated at locations shown or scheduled. Selection is Installer's option where more than one type is indicated.

3.03 INSTALLATION

A. General: Except as otherwise indicated, comply with manufacturer's instructions for 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. Anchor and attach units to substrate and equipment as required for secure operation and to prevent displacement by normal forces, and as indicated.

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

E. Flexible Pipe Connectors: Install on equipment side of shutoff valves, horizontally and parallel to equipment shafts wherever possible.

3.04 EXAMINATION OF RELATED WORK

A. Installer of vibration isolation work shall observe installation of other work related to vibration isolation work, including work connected to vibration isolation work; and, after completion of other related work (but before equipment startup), shall furnish written report to Contractor listing observed inadequacies for proper operation and performance of vibration isolation work. Report shall cover, but not necessarily be limited to the following:

1. Equipment installations (performed as work of other sections) on vibration isolators.
2. Piping connections including flexible connections.

B. Do not start up equipment until inadequacies have been corrected in manner acceptable to vibration isolation Installer.

END OF SECTION 22 05 48
SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Extent of plumbing identification work required by this section is indicated on drawings and/or specified in other Division-22 sections.

B. Type of identification devices specified in this section include the following:
   1. Painted identification materials
   2. Plastic pipe markers
   3. Plastic tape
   4. Valve tags

C. Identification furnished as part of factory fabricated equipment, is specified as part of the equipment assembly in other Division-22 sections.

1.03 QUALITY ASSURANCE

A. ANSI Standards: Comply with ANSI A13.1 for lettering size, colors, and viewing angles of identification devices.

1.04 SUBMITTALS

A. Schedules: Submit valve schedule for each piping system, formatted in an Excel spreadsheet with a digital copy provided to the Owner along with a printed copy on 8-1/2" x 11" paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in margin of schedule. In addition, furnish extra copies for Maintenance Manuals.

B. Labeling Nomenclature: Submit list indicating system types with appropriate nomenclature to be provided on the pipe labels. Where possible, match to system labels on drawings.

PART 2 - PRODUCTS

2.01 IDENTIFICATION MATERIALS

A. General: Provide manufacturer’s standard products of categories and types required for each application as referenced in other Division-22 sections. Where more than one single type is specified for an application, selection is Installer's option, but provide single selection for each product category.

B. Painted Identification Materials:
   1. Stencils: Standard fiberboard stencils, prepared for required applications with letter sizes generally complying with recommendations of ANSI A13.1 for piping and similar applications, but not less than 3/4" high letters for access door signs and similar operational instructions.
2. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray-can form and grade.

3. Identification Paint: Standard identification enamel of colors indicated, or, if not otherwise indicated for piping systems, comply with ANSI A13.1 for colors.

C. Plastic Pipe Markers:


2. Small Pipes: For external diameters not greater than 6" (including insulation if any), provide full-band pipe markers extending 360 degrees around pipe at each location, fastened by one of the following methods:
   a. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
   b. Adhesive lap joint in pipe marker overlap.
   c. Laminated or bonded application of pipe marker to pipe (or insulation).
   d. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4" wide full circle at both ends of pipe marker, tape lapped 1-1/2".

3. Large Pipes: For external diameters of 6" and larger (including insulation if any), provide either full-band or narrow strip-type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:
   a. Laminated or bonded application of pipe marker to pipe (or insulation).
   b. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2" wide; full circle at both ends of pipe marker, tape lapped 3".
   c. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.

4. Lettering: Manufacturer's standard pre-printed nomenclature which best describes piping system in each instance, as selected by Design Professional in cases of variance with names as shown or specified.

5. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as a separate unit of plastic.

D. Plastic Tape:

1. General: Manufacturer's standard color-coded pressure-sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.
   a. Width: Provide 1-1/2" wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6", 2 1/2" wide tape for larger pipes.
   b. Color: Comply with ANSI A13.1, except where another color selection is indicated.

E. Valve Tags:

1. Brass Valve Tags: Provide polished brass valve tags with stamp-engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 7/16" high, and with 3/16" hole for fastener. Tag thickness 0.040 inches.
   a. Provide 2" diameter tags, except as otherwise indicated.
   b. Fill tag engraving with black enamel.
2. Plastic Valve Tags: Provide red heavy plastic tag with 7/16" white embossed sequenced numbers.

3. Valve Tag Fasteners: Manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks or heat sealed braided copper wire of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

F. Name Plates:

1. General: Provide manufacturer’s standard preprinted plastic, brass, or aluminum with stamped, engraved or embossed letters.

2. Lettering:
   a. Large Equipment: 1 1/2" lettering as appropriate.
   b. Small Equipment: 3/4" lettering as appropriate.

3. Attachments: Mounting holes and screws, pressure sensitive adhesive backing, or solid brass chain.

2.02 LETTERING AND GRAPHICS

A. General: Coordinate names, abbreviations and other designations used in plumbing identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of plumbing systems and equipment.

1. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Boiler No. 3, Air Supply No. 1H, Standpipe F12).

PART 3 - EXECUTION

3.01 APPLICATION AND INSTALLATION

A. General Installation Requirements:

1. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish including valve tags, install identification after completion of covering and painting if any. Install identification prior to installation of acoustical ceilings and similar concealment.

B. Access Door Identification:

1. Provide stenciled or plastic-laminate type signs on each access door in ductwork and housings, indicating purpose of access (to what equipment) and other maintenance and operating instructions, and appropriate safety and procedural information.

C. Piping System Identification:

1. General: Install pipe markers of one of the following types on each piping system, and include arrows to show normal direction of flow:
   a. Stenciled markers, including color-coded background band or rectangle, and contrasting lettering of black or white. Extend color band or rectangle 2" beyond ends of lettering.
b. Plastic pipe markers, with application system as indicated under "Materials" in this section.

c. Stenciled markers, black or white for best contrast, wherever continuous color-coded painting of piping is provided.

2. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations. Install all markers such that lettering is visible from the floor.

a. Near each valve and control device.

b. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.

c. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.

d. At access doors, manholes and similar access points which permit view of concealed piping.

e. Near major equipment items and other points of origination and termination.

f. Spaced intermittently at maximum spacing of 20' along each piping run with a minimum of one marker in each room.

g. On piping above removable acoustical ceilings.

D. Valve Identification:

1. General: 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 and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.

E. Equipment Identification:

1. General: Provide equipment identification for all equipment including water heaters, heat exchangers, water softeners, and pumps.

2. Labeling: All equipment shall be labeled as per construction document plan marks or as designated by Owner.

3. Provide identification by means of nameplates or stenciled painting as appropriate.

a. For equipment with factory furnished casing, identification shall be by adhesive fixed name plates.

b. Field insulated items, such as heat exchangers may be identified by plastic pipe markers or stenciled lettering.

END OF SECTION 22 05 53
SECTION 22 07 00 - PLUMBING INSULATION

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this Section.

1.02 DESCRIPTION OF WORK

A. Provide material, equipment, labor and supervision necessary to install insulation to all hot and cold surfaces of piping, tanks, fittings and other surfaces as required by the drawings and this section.

B. Insulation shall include insulating materials, jackets, adhesive, mastic coatings, tie wire and other materials as required to complete the insulating work.

1.03 QUALITY ASSURANCE

A. NFPA Compliance: Insulating materials, jackets, mastics, etc., shall meet flame spread and smoke developed ratings in accordance with NFPA-90A. Flame spread rating of not more than 25, smoke developed rating of not more than 50 as tested by ANSI/ASTM E84 (UL 723) (NFPA 255) method. All accessory items such as PVC jacketing and fittings, adhesive, mastic, cement tape and cloth shall have the same component ratings as specified above.

B. Installation of insulation materials shall be in accordance to the latest edition of MICA/NIAC National Commercial & Industrial Standards for the appropriate material application.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's specifications and installation instructions for each type of plumbing insulation. Submit schedule showing manufacturer's product number, thickness, and furnished accessories for each plumbing system requiring insulation.

B. Maintenance Data: Submit maintenance data and replacement material lists for each type of plumbing insulation. Include this data in maintenance manual.

C. Certifications: Submit certifications or other data as necessary to show compliance with these specifications and governing regulations. Include proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.

1.05 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 ratings of products.

B. Protect insulation against dirt, water, and chemical and plumbing damage. Do not install damaged insulation; remove from project site.
PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Insulating Materials

1. Owens/Corning Fiberglass Corp.
2. Armacell
3. Pittsburgh Corning Corp.
4. CertainTeed Corp.
5. Knauf Fiber Glass
7. Aeroflex

B. Mastics and adhesives as recommended by insulation manufacturer.

2.02 PIPE INSULATION

A. Type 'A': Preformed sectional heavy density fiberglass insulation and factory applied vapor barrier, all service jacket with pressure sensitive self-sealing longitudinal laps and butt strips. Suitable for operating temperatures from 0 to +850 deg. F. Thermal conductivity shall be no more than 0.23 Btu-in/hr-sq.ft.-deg F @ 75 deg. F mean temperature. Water vapor permeance of .02 perms. Equal to Owens Corning 25 ASJ/SSL.

1. Where insulation is exposed to weather outdoors it shall be covered with an aluminum or stainless steel weatherproof jacket 0.016" thick and sealed.

2. Where insulation is exposed in indoor occupied space and within 8 feet of finished floor, it shall be covered with 30 mil PVC jacket equal to Johns Manville Zeston.

3. Where insulation is exposed in a mechanical room and is within 6 feet of finished floor, it shall be covered with a 0.016” aluminum jacket.

B. Type 'B': Flexible elastomeric extruded pipe covering, 6 pound density, 0.27 K factor, water vapor permeance of 0.20 perms. Suitable for temperature from -40 deg. F to +220 deg. F. Equal to Armacell, AP Armaflex, joints sealed with adhesive as recommended by insulation manufacturer.

1. Where insulation is exposed to weather outdoors it shall be covered with an aluminum or stainless steel weatherproof jacket 0.016” thick and sealed.

2. Where insulation is exposed in indoor occupied space and within 8 feet of finished floor, it shall be covered with 30 mil PVC jacket equal to Johns Manville Zeston.

3. Where insulation is exposed in a mechanical room and is within 6 feet of finished floor, it shall be covered with a 0.016” aluminum jacket.

2.03 FITTING INSULATION

A. Type 'A1': Fittings: Insulate with mitered segments of same insulating material as for adjacent pipe covering, or with pre-molded fiberglass wired in place and covered with all-service jacket or low smoke PVC fitting covers. Valve bodies, strainer bodies, flanges, etc.: insulate with single or multiple layers of same insulating material as for adjacent pipe covering, wired in place and covered with all-service jacket.
B. Type 'B1': Fittings: Insulate fittings, valve bodies, strainer bodies, etc., with mitercut pipe insulation or sheet insulation of same material as pipe covering.

2.04 EQUIPMENT INSULATION

A. Type ‘G’:

1. Rigid fiberglass insulation board with factory applied all service jacket. Suitable for operating temperatures of 0 to +850 deg. F. Water vapor permeance of .02 perms. Equal to Owens Corning Series 700 with 25 ASJ facing.

2. Cut or miter insulation where necessary to fit the shape and contour of the equipment. On round surfaces band insulation in place with 3/4" x 0.015" thick galvanized steel bands 18” on center. On flat or irregular surfaces impale insulation over welded pins on 12” centers and secure with speed washers.

3. Apply vapor seal ASJ pressure-sensitive patches at damaged areas. All insulation edges and butt joints are to be sealed with pressure-sensitive joint sealing tape to match the jacket. Apply in accordance with manufacturers recommendations.

B. Type ‘I’:

1. Flexible elastomeric insulation. Suitable for operating temperatures of -40 to +220 deg. F. Equal to Armacell Armaflex II Sheet Insulation.

2. Cut insulation where necessary to fit the shape and contour of the equipment. Insulation shall be installed using Armacell 520 Adhesive.

3. Exposed outdoor insulation shall be finished with two coats of Armacell Armaflex finish.

PART 3 - EXECUTION

3.01 Use only experienced applicators regularly engaged in the trade. Rough work will be rejected. Application details shall be in accordance with the insulating materials supplier’s recommendations except where a higher standard is specified. All surface finishes shall be extended in such a manner as to protect all raw edges, cuts and surfaces of insulation.

3.02 Do not insulate the following:

A. Valve bonnets
B. Unions in hot piping
C. Preinsulated expansion joints

3.03 Inspect all piping and equipment before applying insulation to insure the installing contractor has completed all leak tests, and that all surfaces are clean, dry and ready for application of insulation.

3.04 Covering for "cold" pipes shall pass unbroken through hanger clevises, sleeves, etc. All details of covering for cold surfaces shall be such that continuous covering with unbroken vapor barrier and uncompressed insulation is provided as required to prevent condensation. The same covering and hanging detail shall be used for pipes connecting to vibrating equipment or carrying pulsating pressures to avoid metal contact between pipes and hangers.

3.05 Insulation at removable heads, manhole covers, strainer plugs, and other access points shall be fabricated in such a manner that it can be readily removed without damage to the insulation. Removable insulation shall have a vapor proof cover fabricated so as to allow it to be resealed to the equipment vapor barrier.
3.06 INSULATION SCHEDULE

<table>
<thead>
<tr>
<th>Service</th>
<th>Type Insulation and Thickness *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above Ground Piping</td>
<td></td>
</tr>
<tr>
<td>Domestic cold water lines</td>
<td><strong>Type A and A1:</strong></td>
</tr>
<tr>
<td></td>
<td>All pipe sizes – 1” thick</td>
</tr>
<tr>
<td></td>
<td><strong>Type B and B1:</strong></td>
</tr>
<tr>
<td></td>
<td>1-1/4” and smaller – 1/2” thick</td>
</tr>
<tr>
<td></td>
<td>1-1/2” and larger – 1” thick</td>
</tr>
<tr>
<td>Domestic hot water, tempered water, and recirculating lines</td>
<td><strong>Type A and A1:</strong></td>
</tr>
<tr>
<td></td>
<td>1 1/4” and smaller – 1” thick</td>
</tr>
<tr>
<td></td>
<td>1-1/2” and larger – 1-1/2” thick</td>
</tr>
<tr>
<td></td>
<td><strong>Type B and B1:</strong></td>
</tr>
<tr>
<td></td>
<td>1 1/4” and smaller – 1” thick</td>
</tr>
<tr>
<td></td>
<td>1-1/2” and larger – 1-1/2” thick</td>
</tr>
<tr>
<td>Horizontal and vertical portions of above grade storm piping, sump</td>
<td><strong>Type A and A1:</strong></td>
</tr>
<tr>
<td>pump discharge lines, sanitary vent piping within ten feet of roof</td>
<td>1” thick for all pipe sizes</td>
</tr>
<tr>
<td>penetration</td>
<td></td>
</tr>
<tr>
<td>Underside of roof drain bodies</td>
<td><strong>Type G:</strong> 1” thick</td>
</tr>
<tr>
<td>Steam domestic water heaters – piping and components as part of system</td>
<td><strong>Type A and A1:</strong></td>
</tr>
<tr>
<td>package</td>
<td>1-1/4” and smaller - 1-1/2” thick</td>
</tr>
<tr>
<td></td>
<td>1-1/2” and larger - 2” thick</td>
</tr>
<tr>
<td>Steam domestic water heaters – heat exchanger</td>
<td><strong>Type G:</strong> 2” thick.</td>
</tr>
<tr>
<td>Underground Piping</td>
<td></td>
</tr>
<tr>
<td>Domestic hot water lines and recirculation lines</td>
<td><strong>Type B and B1:</strong></td>
</tr>
<tr>
<td></td>
<td>1 1/4” and smaller – 1” thick</td>
</tr>
<tr>
<td></td>
<td>1-1/2” and larger – 1-1/2” thick</td>
</tr>
</tbody>
</table>

* For piping exposed to outdoor ambient temperatures, increase thickness by 1/2”

END OF SECTION 22 07 00
SECTION 22 11 16 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 22 001 0 - Plumbing General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Contractor shall furnish all equipment, materials, tools, labor and supervision necessary to fabricate and install complete piping system as required by the drawings and this section.

1. Extent of domestic water piping work is indicated on drawings and schedules, and by requirements of this section.

2. Insulation of domestic water piping is specified in other Division-22 sections, and is included as work of this section.

3. Installation of valves for domestic water piping system is specified in other Division-22 sections and is included as work of this section.

1.03 QUALITY ASSURANCE

A. ASME Compliance: Fabricate and install domestic water piping in accordance with ASME B31.9 "Building Services Piping".

B. IPC Compliance: Fabricate and install domestic water piping in accordance with the "International Plumbing Code".

C. Plumbing and Drainage Institute: Fabricate and install domestic water piping with Standard PDI-WH201.

D. ANSI/NSF 372 Certification: All potable water supply piping, valves, fittings, and fixtures (excluding toilets, urinals, fill valves, flush valves, shower valves, and main gate valves greater than 2") shall meet the requirements for ANSI/NSF 372 Certification, Drinking Water System Components, Lead Content.

1.04 SUBMITTALS

A. Submit manufacturer's material data and installation methods for each type of system to be provided.

B. Submit manufacturer’s catalog cuts for each type of device to be used.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Backflow Preventers

1. Watts
2. Apollo Valves
3. Febco
B. Water Hammer Arrestors
   1. Ancon
   2. Sioux Chief
   3. Wade
   4. Watts
   5. Zurn

C. Copper Pressure Seal Fittings
   1. Viega Pro Press
   2. NIBCO Press System

2.02 BASIC MATERIALS AND PRODUCTS

A. General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide materials and products complying with Uniform Plumbing Code and International Plumbing Code where applicable, base pressure rating on domestic water piping system's maximum design pressures. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in domestic water piping systems. Where more than one type of materials or products are indicated, selection is Installer's option.

B. Valves: Refer to Section 22 05 23 - General Duty Valves for Plumbing Piping.

C. Piping Specialties: Refer to Section - 22 05 00 - Common Work Results for Plumbing.

D. Expansion Compensation: Refer to Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping.

E. Meters and Gauges: Refer to Section 22 05 19 - Meters and Gages for Plumbing Piping.

F. Supports, Anchors and Seals: Refer to Section 22 05 29 - Hangers and Supports for Plumbing Piping.

2.03 PIPE:

<table>
<thead>
<tr>
<th>Material</th>
<th>Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Cast iron water pipe, standard mechanical joint, asphalt coated, Class 150. ANSI A21.1, AWWA C106.</td>
<td>Underground water service main 2&quot; dia. and larger.</td>
</tr>
<tr>
<td>B. Ductile iron pipe ANSI A21.5 ANSI/AWWA C151.</td>
<td>Underground water service main, 4&quot; dia. and larger. Above ground water service main for combined domestic/fire service, up to fire Protection backflow preventer</td>
</tr>
<tr>
<td>C. Polyvinyl Chloride Pipe (PVC) DR18 ANSI/AWWA C900 or C905 With tracer wire</td>
<td>Underground water service main.</td>
</tr>
</tbody>
</table>
D. Copper water tube, hard temper, ASTM B88.

Type K: Domestic water lines under building. Water service pipe 2” and smaller.

Type L: Above ground domestic water lines.

E. Brass pipe, Schedule 40, chromium plated. ASTM B43. Exposed piping connections for plumbing fixtures.

F. Cross-Linked Polyethylene (PEX), ASTM F876 and ASTM 877. Above ground domestic water lines, as permitted by local code.

2.04 FITTINGS:

A. Cast iron water pipe: Class 250 ANSI A21.20, AWWA C110-71, standard mechanical joint fittings.

B. Copper water tube cast bronze or wrought copper:

1. Solder joint type. ANSI B16.18 and B16.22-63. Where copper piping is used for combined water/fire protection water service, joints upstream of fire protection backflow preventer shall be brazed.

2. Pressure Seal pipe joining system, copper press fittings, 1/2” to 4” in diameter. ASME B16.18, ASME B16.22. O-rings for copper press fittings shall be EPDM. Installation per manufacturer’s recommendations.

C. Brass pipe: Cast bronze screwed, 125 pound, flat band water pattern, chromium plated, for chromium plated pipe.

D. Cross-Linked Polyethylene (PEX) (domestic water): ASTM F1807 Metal insert fittings utilizing copper crimp ring. ASTM F877 polysulfone (PSL) fittings provided by and recommended for the service indicated by manufacturer of piping.

2.05 JOINTS

A. Copper water tube:

1. Use non-corrosive 95-5 tin-antimony solder, cut pipe square, clean, ream and polish tube ends and inner surfaces of fittings, apply flux and solder joint as recommended by manufacturer of solder type fittings. Where copper piping is used for combined water/fire protection water service, joints upstream of fire protection backflow preventer shall be brazed.

2. Pressure Seal pipe joining system, copper press fittings, 1/2” to 4” in diameter. ASME B16.18, ASME B16.22. O-rings for copper press fittings shall be EPDM.

B. Cross-Linked Polyethylene (PEX) (domestic water): ASTM F1807 Compression joint utilizing copper crimp ring. ASTM F877 polysulfone (PSL) compression joint provided by and recommended for the service indicated by manufacturer of piping.

2.06 NIPPLES AND UNIONS

A. All nipples shall conform to size, weight and strength of adjoining pipe. When length of unthreaded portion of nipple is less than 1-1/2”, use extra strong nipple; do not use close nipples.
B. For pipe 2“ and smaller, use screwed unions, for pipe 2-1/2“ and over use flanged unions.

C. Install unions in the following locations so that a minimum amount of pipe need be disassembled:

1. Long runs, at intervals of 80 feet.
2. In by-pass around equipment, valves, and controls.
3. In connections to equipment.
4. Where indicated on drawings.

D. Dielectric unions shall be installed between any connection of copper pipe and ferrous piping or equipment. In grooved piping systems, provide Clearflo by Victaulic.

2.07 AIR VENTS

A. Manual Air Vents: Bell & Gossett Model No. 17SR.

B. Automatic Air Vents: Bell & Gossett Model No. 7

2.08 BACKFLOW PREVENTERS

A. Reduced Pressure Zone Backflow Preventer:

1. General: A reduced pressure zone backflow preventer shall be installed at each cross connection or at the water meter to prevent back-siphonage and backpressure backflow of hazardous materials into the potable water supply.

2. The device shall consist of a pressure differential relief valve located in a zone between two positive seating check valves. The assembly shall include two tightly closing shut-off valves before and after the device, test cocks and a protective strainer upstream of the No. 1 shut-off valve. The reduced pressure zone backflow preventer shall have all access port covers secured with stainless steel screws which are bolted to valve body. Vent outlet to have suitable connections for an air gap. All components of the backflow preventer assembly shall meet the requirements for ANSI/NSF 372 Certification, Drinking Water System Components, Lead Content.

3. The device shall meet the requirements of ANSI/ASSE Standard 1013 and AWWA Standard C506, be listed by IAPMO (UPC) and be approved by FCCCHR at USC. Provide with air gap fitting for discharge. Basis of design to be:

   b. Watts Regulator Co. Series 909 – size 3/4“ thru 10“.

4. Provide and install solenoid shutdown valve. This valve shall be designed to be normally open and located upstream of an RPZ backflow assembly. It will automatically shut down water flow if the RPZ relief valve discharge capacity causes a flooding situation. If excess discharge does occur, the discharge flow causes the WATTS FS99 Flow Switch to send a signal to the WATTS ACV JB113 Junction Box which sends a signal to energize the solenoid on the 113-6RFP to shut down the main valve. A timer is supplied in the JB113 Junction Box to prevent the 113-6RFP from closing on intermittent discharges from the RPZ relief valve. Once closed, the 113-6RFP valve must be manually reset. The main valve stem shall be equipped with a position indicator or optional limit switch for remote signaling. Valve shall be WATTS ACV Model 113-RFP with JB113 Junction Box. The WATTS FS99 Flow Switch should be located on a horizontal plane avoiding turbulence of piping bends and elbows.
B. Reduced Pressure Zone Backflow Preventer: Pressure Vacuum Breakers: A pressure anti-siphon vacuum breaker shall be installed at all threaded hose connections and where indicated on the plans to prevent the back-siphonage of contaminated water. This assembly is not to be used where there is a possibility that a back pressure condition may develop. The assembly will incorporate an acetyl bonnet with silicone rubber o-ring seal and silicone rubber seat disc. The valve shall have replaceable seats. Check assembly shall be guided over its full stroke by AV® notched guides. The assembly shall meet the requirements of ANSI/ASSE Standard 1020. Where vacuum breaker is not integral to trim, unit shall be equal to Watts Regulator Company Series 800M4QT.

2.09 WATER HAMMER ARRESTORS

A. Water hammer arrestors shall be piston type with seamless copper chamber, two O-ring piston and a 60 psi charge. Water hammer arrestors shall be sized, tested and certified in accordance with the Plumbing and Drainage Institute Standard PDI-WH201 and American Society of Sanitary Engineering Standard ASSE-1010.

PART 3 - EXECUTION

3.01 INSPECTION

A. General: Examine areas and conditions under which domestic water piping systems materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.02 INSTALLATION OF BASIC MATERIALS AND PRODUCTS

A. General: Install basic materials and products as per manufacturers' recommendations, Uniform and International Plumbing Codes, local code requirements and as required to meet system pressure and performance requirements.

B. Valves

1. Refer to Section 22 05 23 - General Duty Valves for Plumbing Piping.

2. Locate valves for easy access and operation. Do not locate valves with stems below horizontal.

3. Sectional Valves: Install on each branch and riser, close to main, where branch or riser serves 2 or more plumbing fixtures and elsewhere as indicated.

4. Shutoff Valves: Install on inlet and outlet of each domestic water equipment item and elsewhere as indicated.

5. Check Valves: Install on discharge side of each pump, and elsewhere as indicated.

C. Piping Specialties: Refer to Section 22 05 00 - Common Work Results for Plumbing.

D. Expansion Compensation Products: Refer to Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping.

E. Meters and Gauges: Refer to Section 22 05 19 - Meters and Gages for Plumbing Piping.

F. Supports and Anchors: Refer to Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment.
3.03 DOMESTIC WATER PIPING
A. Install pipe for all domestic water and domestic water systems as indicated on drawings, as called for in other sections, and as specified herein.
B. Arrange and install piping approximately as indicated; straight, plumb, and as direct as possible; form right angles on parallel lines with building walls. Keep pipes close to walls and avoid interference with other trades. Locate groups of pipes parallel to each other; space at a distance to permit applying full insulation and to permit access for servicing valves. Most piping to be run in concealed locations unless indicated exposed, or in equipment rooms. Locate piping to avoid ductwork.
C. Install horizontal piping as high as possible without sags or humps so that proper grades can be maintained for drainage.
D. Check all piping for interference with other trades; avoid placing water pipes over electrical equipment.
E. Where rough-in is required for equipment furnished by others, verify exact rough-in dimension with owner or equipment supplier before roughing-in.
F. Extend cold water and hot water piping to each fixture and other equipment requiring water supplies.
G. Pitch pipes to accessible drainage point where unions, plugged tees or drainage valves shall be provided.
H. Connect branch-feed piping to mains at horizontal centerline of mains; connect run-out piping to branches at horizontal centerline of branches.
I. Pipes built into masonry or concrete construction shall be wrapped with tar paper or burlap to prevent bonding to the concrete.
J. No pipe shall be located in an outside wall or other location where freezing is likely to occur.
K. No pipe shall be in contact with, or attached to, a structural member in a manner that causes the transmission of noise to the structure. Block ends of runs to prevent movement due to water hammer.

3.04 EQUIPMENT CONNECTIONS
A. Refer to Section 22 11 23 - Domestic Water Pumps and 22 34 00 - Fuel Fired Domestic Water Heaters.
B. General: Connect domestic water piping system to plumbing equipment as indicated, and comply with equipment manufacturer's instructions where not otherwise indicated. Install shutoff valve and union on supply and return, drain valve on drain connection.

3.05 INSTALLATION OF FIXTURES
A. Refer to Section 22 40 00 - Plumbing Fixtures and 22 47 00 - Drinking Fountains and Water Coolers.
B. General: Connect water piping system to plumbing fixtures as indicated, and comply with manufacturer's instructions where not otherwise indicated.
C. Refer Water supply to all fixtures and containers shall be so installed as to prevent back siphonage of polluted water into the water supply. All supplies shall be either above the flood rim of the fixture or separated from the drainage end by means of approved vacuum breakers.

3.06 INSTALLATION OF BACKFLOW PREVENTERS

A. Install backflow preventers where required per local code and in accordance with manufacturer=s recommendations. Backflow preventers to be installed accessible for testing, installing contractor shall provide testing by a certified backflow assembly tester at time of installation as required by the International Plumbing Code. Install air gap fitting and pipe to nearest floor drain.

3.07 INSTALLATION OF WATER HAMMER ARRESTORS

A. Install water hammer arrestors as indicated on the drawings and as required per Plumbing and Drainage Institute Standard PDI-WH201. Water hammer arrestors to be installed in accessible locations where possible.

3.08 INSTALLATION OF PLUMBING SPECIALTIES

A. General: Install plumbing specialties and valves as per manufacturer=s installation instructions.

B. Provide unions, valves to units at each connection as required by inspection.

3.09 HYDROSTATIC TESTING

A. General: New water mains shall be subject to hydrostatic testing in accordance with AWWA C600 and other applicable AWWA Standards of latest revision and the following supplemental instructions.

B. Supplemental Instructions:

1. All newly laid pipe or any valved section thereof shall be subject to a hydrostatic pressure of 1.5 X the working pressure at the point of testing or 100 psig, whichever is greater.

2. The test procedures shall:
   a. Not exceed pipe or thrust restraint design pressures.
   b. Be of at least 4-hour duration.
   c. Not exceed the rated pressure of the valves or hydrants.

3. Each valved section of pipe shall be filled with water slowly and the specified test pressure shall be applied by means of a pump connected to the pipe.

4. Before applying the specified test pressure, air shall be expelled completely from the pipe, valves and hydrants.

5. Any damaged or defective pipe, fittings, valves or hydrants that are discovered following the pressure test shall be repaired or replaced with sound material and the test shall be repeated.

6. A leakage test shall be conducted concurrently with the pressure test. Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe, or any valved section thereof, to maintain test pressure.

7. No pipe installation will be accepted where leakage is observed.
3.10 DISINFECTION

A. General: Upon completion of a newly installed piping or when repairs to an existing pipe are made, the piping shall be disinfected according to instructions listed in AWWA C601, local codes, local utility requirements, and the following supplemental instructions.

B. Repairs: Repairs to mains and plumbing shall be disinfected by swabbing with hypochlorite and flushing in accordance with AWWA C601.

END OF SECTION 22 11 16
SECTION 22 11 23 - DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Extent of plumbing pumps work required by this section is indicated on drawings and schedules, and by requirements of this section.

B. Types of pumps specified in this section include the following:
   1. In-line Circulators
   2. In-line Pumps

C. 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 pumps. Include starters, disconnects and required electrical devices, except where specified as furnished, or factory installed, by manufacturer.

1.03 QUALITY ASSURANCE

A. UL Compliance:  Design, manufacturer and install pumps in accordance with UL 778 "Motor Operated Water Pumps".

B. UL and NEMA Compliance:  Provide electric motors and components which are listed and labeled by Underwriters Laboratories and comply with NEMA standards.

C. ANSI/NSF 372 Certification:  Domestic Water Pumps shall meet the requirements of ANSI/NSF 372 Certification, Drinking Water System Components, Lead Content.

1.04 SUBMITTALS

A. Product Data:  Submit manufacturer's pump specifications, installation and start-up instructions, and current accurate pump characteristic performance curves with selection points clearly indicated.

B. Shop Drawings:  Submit manufacturer's assembly type shop drawings indicating dimensions, weight loadings, required clearances and method of assembly of components.

C. Wiring Diagrams:  Submit manufacturer's electrical requirements for power supply wiring to pumps. 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.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Handle pumps and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged pumps or components; replace with new.
B. Store pumps and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris and physical damage.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. In-Line Circulators and Pumps

1. Armstrong Pumps, Inc.
2. Aurora
3. Bell & Gossett ITT; Fluid Handling Div.
4. Grundfos
5. Taco, Inc.

B. General: Provide factory tested pumps, thoroughly cleaned and painted with one coat of machinery enamel prior to shipment. Type, size and capacity of each pump is listed in pump schedule. Provide pumps of same type by same manufacturer.

2.02 IN-LINE CIRCULATORS

A. General: Provide in-line circulator pumps where indicated, and of capacities as scheduled. In-line circulators shall be of either all bronze or stainless steel construction.

B. Type: Horizontal mount, permanently lubricated, designed for 150 psi working pressure and 225 deg. F continuous water temperature.

C. Construction: Cast bronze or stainless steel body with suction and discharge flanges. Steel shaft mounted on permanently lubricated, sealed ball-bearings. Water-tight seal fill mechanical carbon on silicon carbide face seals.

D. Impeller: Composite construction, enclosed type, hydraulically and dynamically balanced, and keyed to shaft.

E. Motor: Non-overloading at any point on pump curve, drip-proof, permanently sealed ball bearings, resilient mounted construction, permanent split capacitor with thermal overload protection, single phase motors.

F. Controls: Provide circulator with integral time clock.

2.03 IN-LINE PUMPS

A. General: Provide in-line centrifugal pumps where indicated, and of capacities as scheduled. In-line pumps shall be of all bronze construction.

B. Type: Single-stage, close-coupled, vertical split case design, horizontal mount, permanently lubricated type, designed for 175 psi working pressure, and 225 deg. F continuous water temperature.

C. Construction: Cast bronze body with suction and discharge flanges, gauge (suction and discharge), vent and drain ports. Solid steel shaft with bronze shaft-sleeve, mounted on permanently lubricated, sealed ball-bearings. Internally flushed, carbon, mechanical seals. The pump internals shall be capable of being services without disturbing piping connections.
D. Impeller: Cast bronze, hydraulically and dynamically balanced, keyed to the shaft and secured by a locking brass cap screw or nut.

E. Coupling: A flexible type coupling shall be employed between the pump and motor.

F. Motor: Motors through 1 HP shall be resilient mounted, motors over 1.5 HP shall be rigid mounted. Motors shall have permanently lubricated ball bearings and maintenance free. Motors shall be non-overloading at any point on the pump curve and shall meet NEMA specifications.

G. Each pump shall be factory tested per Hydraulic Institute standards. It shall then be thoroughly cleaned and painted with at least one coat of high grade machinery enamel prior to shipment.

PART 3 - EXECUTION

3.01 INSPECTION

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

3.02 INSTALLATION OF PUMPS

A. General: Install plumbing pumps where indicated, in accordance with manufacturer's published installation instructions, complying with recognized industry practices to ensure that pumps comply with requirements and serve intended purposes.

B. Access: Provide access space around pumps for service as indicated, but in no case less than that recommended by manufacturer.

C. Support: Install in-line pumps, supported from piping system. See Section 22 0548 - Vibration and Seismic Controls for Plumbing Piping and Equipment for vibration isolation of piping system.

D. Controls: Install devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer for power wiring.

1. Verify that wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

E. Piping Connections: Refer to Division-22 Plumbing piping sections. Provide piping, valves, accessories, gauges and supports as indicated, including the following:

1. Strainer and shut-off valve in suction line.
2. Check valve, balancing/shut-off valve in discharge line. At contractor's option, an indicating type butterfly valve may be used in lieu of balancing cock and shut-off valve.
3. Compound gauge with turn cocks connected between pump suction and discharge.

3.03 ADJUSTING AND CLEANING

A. Alignment: Check alignment, and where necessary, realign shafts of motors and pumps within recommended tolerances by manufacturer, and in presence of manufacturer's service representative.

B. Start-up: Lubricate pumps before start-up. Start-up in accordance with manufacturer's instructions.
C. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 22 11 23
SECTION 22 13 16 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.01 RELATED WORK
A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK
A. Contractor shall furnish all equipment, materials, tools, labor and supervision necessary to fabricate and install complete piping system as required by the drawings and this section.
   1. Extent of sanitary waste and vent piping work is indicated on drawings and schedules, and by requirements of this section.

1.03 QUALITY ASSURANCE
A. IPC Compliance: Fabricate and install sanitary waste and vent piping in accordance with the "International Plumbing Code".
B. Plumbing and Drainage Institute: Fabricate and install domestic water piping with Standard PDI-WH201.

1.04 SUBMITTALS
A. Submit manufacturer’s catalog cuts for each type of device to be used.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS
A. Floor Drains
   1. Jay R. Smith
   2. Jonespec
   3. Josam
   4. Wade
   5. Watts
   6. Zurn

2.02 BASIC MATERIALS AND PRODUCTS
A. General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide materials and products complying with International and Uniform Plumbing Codes. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in sanitary waste and vent piping systems. Where more than one type of materials or products are indicated, selection is Installer's option.
B. Piping Specialties: Refer to Section - 22 05 00 - Common Work Results for Plumbing.
C. Supports, Anchors and Seals: Refer to Section 22 05 29 - Hangers and Supports for Plumbing Piping.
### 2.03 PIPE:

<table>
<thead>
<tr>
<th>Material</th>
<th>Service</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A.</strong> Cast iron soil pipe, service class, bell and spigot, asphalt coated, ASTM A74.</td>
<td>Below grade sanitary sewers under building. Above ground soil, waste, and vent.</td>
</tr>
<tr>
<td><strong>B.</strong> Cast iron soil pipe, service class, no hub, asphalt coated CISPI 301 or ASTM A-888.</td>
<td>Below grade sanitary sewers, above ground soil, waste, and vent as permitted by local code.</td>
</tr>
<tr>
<td><strong>C.</strong> Polyvinyl Chloride Pipe (PVC) Schedule 40, DWV, ASTM D1785 and ASTM D2665.</td>
<td>Below grade sanitary sewers, above ground soil, waste, vent, and condensate drain lines as permitted by local code. Shall not be used in above ceiling air plenums.</td>
</tr>
<tr>
<td><strong>D.</strong> Copper water tube, hard temper, ASTM B88.</td>
<td>Underground condensate drain line.</td>
</tr>
<tr>
<td><strong>Type K</strong></td>
<td>Above ground soil, waste, and vent up to and including 2-1/2” diameter. Above ground condensate drain lines. As permitted by local code.</td>
</tr>
<tr>
<td><strong>E.</strong> Brass pipe, Schedule 40, chromium plated. ASTM B43.</td>
<td>Exposed piping connections for plumbing fixtures.</td>
</tr>
</tbody>
</table>

### 2.04 FITTINGS:

<table>
<thead>
<tr>
<th>Material</th>
<th>Service</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A.</strong> Material and strength of fitting for cast iron sewer pipe, clay sewer pipe and concrete sewer pipe shall conform to pipe as per ASTM Standards.</td>
<td></td>
</tr>
<tr>
<td><strong>B.</strong> PVC pipe fittings (below grade sanitary sewer): Provide fittings produced and recommended for the service indicated by manufacturer of piping.</td>
<td></td>
</tr>
<tr>
<td><strong>C.</strong> PVC DWV pipe fittings: ASTM D2665 DWV Schedule 40 socket type. Provide fittings produced and recommended for the service indicated by manufacturer of tubing. Solvent cements as per ASTM 2564.</td>
<td></td>
</tr>
<tr>
<td><strong>D.</strong> Copper drainage tube: Cast bronze fittings, solder joint fittings. ANSI B16.23.</td>
<td></td>
</tr>
<tr>
<td><strong>E.</strong> Brass pipe: Cast bronze screwed, 125-pound, flat band water pattern, chromium plated, for chromium plated pipe.</td>
<td></td>
</tr>
</tbody>
</table>

### 2.05 JOINTS:

<table>
<thead>
<tr>
<th>Material</th>
<th>Service</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A.</strong> Vitrified clay and concrete pipe: Pipe manufacturer's standard preformed pre-set plastic or rubber joint, installed in accordance with manufacturer's instructions. Acceptable manufacturers: Amvit, Tylox or Kent.</td>
<td></td>
</tr>
</tbody>
</table>
B. Cast iron bell and spigot soil pipe: Pack joints with oakum, fill with molten lead at one pouring, caulk solid flush with hub rim. If approved by Code, pre-set plastic or neoprene joint may be used, ASTM C 564.

C. Cast iron no-hub pipe: Coupling assembly tightened by torque wrench, CISPI 310, ASTM C 564.

D. PVC pipe fittings (below grade sanitary sewer): Listed compression type joints.

E. PVC DWV pipe: Solvent cement in accordance with ASTM D2564.

F. Copper drainage tube: Use non-corrosive 50-50 solder, cut pipe square, clean, ream and polish tube ends and inner surface of fittings, apply flux and solder joint as recommended by manufacturer of solder type fittings. Use same method for copper refrigerant pipe, except use silver solder with 5% silver content, or equal strength brazing alloy.

2.06 VENTS

A. Vents through the roof shall be cast iron long increasers beginning at 12" under the roof and extending at least above the highest possible water level on the roof but in no case less than 8". Size increases as follows:

<table>
<thead>
<tr>
<th>Vent Size</th>
<th>Increase To</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1/4&quot; and 1-1/2&quot;</td>
<td>3&quot; minimum</td>
</tr>
<tr>
<td>2&quot; and 2-1/2&quot;</td>
<td>4&quot; minimum</td>
</tr>
<tr>
<td>3&quot;</td>
<td>4&quot;</td>
</tr>
<tr>
<td>4&quot;</td>
<td>6&quot;</td>
</tr>
</tbody>
</table>

B. Provide and install flashing for each vent through the roof. The flashing shall extend up around the pipe and be sealed to the pipe and shall extend over the roof deck at least one foot in each direction from the base.

2.07 FLOOR DRAINS

A. Shall be of the style as called for in fixture schedule.

B. Drains without integral traps shall have service class p-traps.

2.08 CLEANOUTS

A. In floors of finished areas: cast iron caulking ferrule for soil pipe hub with brass countersunk plug and cast brass round flush access cover with polished top.

B. In floors of unfinished areas: cast iron with tapered body for caulking into soil pipe hub, with brass countersunk plug.

C. In walls of finished areas: cast brass raised head plug and round stainless-steel cover plate with polished top and countersunk cover screw. Provide with caulking ferrule where installed in cast iron soil pipe.

D. In walls of unfinished areas: cast brass raised head, iron pipe size male threads. Provide with caulking ferrule where installed in iron soil pipe.

E. In floors of areas subject to vehicular travel: cast iron with tapered body for caulking into soil pipe hub, with brass countersunk plug. Weight rated for fork truck and heavy traffic duty.
PART 3 - EXECUTION

3.01 INSPECTION

A. General: Examine areas and conditions under which sanitary waste and vent piping systems materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.02 INSTALLATION OF BASIC MATERIALS AND PRODUCTS

A. General: Install basic materials and products as required per manufacturer's recommendations, International and Uniform Plumbing Codes, local code requirements and as required to meet the intent of the documents.

B. No soil or waste pipe shall be covered by earth or construction without first being proved free of leaks by a hydrostatic test of at least 10 feet head.

C. Install vents in practical alignment and supported with constant pitch back to the drainage system, concealed from finished spaces, unless shown or directed otherwise.

D. Soil, waste and vent connections to fixtures shall be accurately located and concealed from finished spaces, unless indicated otherwise.

E. Connections to horizontal branches shall be at 45 deg. angle using Wye or Tee-Wye. Connection to vertical stacks shall be with Sanitary Tee or Tee-Wye at 45 deg.

3.03 SANITARY WASTE AND VENT PIPING

A. Install pipe for all sanitary waste and vent systems as indicated on drawings, as called for in other sections, and as specified herein.

B. Arrange and install piping approximately as indicated; straight, plumb, and as direct as possible; form right angles on parallel lines with building walls. Keep pipes close to walls and avoid interference with other trades. Locate groups of pipes parallel to each other; space at a distance to permit applying full insulation and to permit access for servicing valves. Most piping to be run in concealed locations unless indicated exposed, or in equipment rooms. Locate piping to avoid ductwork.

C. Provide proper support to maintain uniform fall of 1/4" per foot for lines 3" and smaller and 1/8" per foot for lines 4" and larger. Protect all openings against the entrance of dirt. Where piping must cross footings, the piping shall cross under footings unless noted otherwise on the drawings.

D. Check all piping for interference with other trades, avoid placing water pipes over electrical equipment.

E. Where rough-in is required for equipment furnished by others, verify exact rough-in dimension with owner or equipment supplier before roughing-in.

F. Piping Specialties: Refer to Section 22 05 00 - Common Work Results for Plumbing.

G. Supports, Anchors and Seals: Refer to Section 22 05 29 - Hangers and Supports for Plumbing Piping.
H. Equipment Connections

1. General: Connect sanitary waste and vent piping system to plumbing equipment as indicated, and comply with equipment manufacturer's instructions where not otherwise indicated. Install shutoff valve and union on supply and return, drain valve on drain connection.

I. Field Quality Control

1. Piping Tests: Test sanitary waste and vent piping in accordance with testing requirements of Division-22 Basic Materials and Methods, Section 22 0010 - Plumbing General Provisions.

3.04 INSTALLATION OF CLEANOUTS

A. Provide a cleanout at the base of each stack where the sewer leaves the building and at other points where required by code and good practice. Cleanout spacing shall not exceed 50'-0" on long runs. Cleanouts shall be the same size as pipe up to and including 4" and 4" for 4" or larger pipes. Cleanouts for concealed pipes shall be set flush with floor and wall surfaces.

3.05 INSTALLATION OF FLOOR DRAINS

A. Obtain exact finish floor levels from the General Contractor and set floor drain top rims accurately to proper level. Allow for proper slope towards drains.

3.06 INSTALLATION OF FIXTURES

A. Refer to Section 22 40 00 - Plumbing Fixtures and 22 47 00 - Drinking Fountains and Water Coolers.

END OF SECTION 22 13 16
SECTION 22 13 19 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Provide material, equipment, labor and supervision necessary for the plumbing fixture installation as required by the drawings and this section.

B. Fixtures, trim and accessories shall be of type and model numbers as scheduled on the drawings.

1.03 SUBMITTALS

A. Submit catalog cuts giving manufacturer's model numbers, fixture and rough-in dimensions, and construction material for each type of fixture, trim and accessory scheduled.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Grease Interceptors

1. Josam
2. Mifab
3. Wade
4. Watts

PART 3 - EXECUTION

3.01 Install grease interceptor and make waste and vent connections as indicated on the drawings.

3.02 Grease interceptor shall be covered after they are set to prevent damage during the balance of construction. At the conclusion of work, the covering shall be removed and the lid properly cleaned at construction completion.

END OF SECTION 22 13 19
SECTION 22 14 13 - FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Contractor shall furnish all equipment, materials, tools, labor and supervision necessary to fabricate and install complete piping system as required by the drawings and this section.

1. Extent of storm drainage piping work is indicated on drawings and schedules, and by requirements of this section.

2. Insulation of storm drainage piping is specified in other Division-22 sections, and is included as work of this section.

1.03 SUBMITTALS

A. Submit catalog cuts giving manufacturer's model numbers, rough-in dimensions, and construction material for each type of site drain and roof drain.

B. Submit material data and installation method for each piping service.

1.04 QUALITY ASSURANCE

A. IPC Compliance: Fabricate and install storm drainage piping in accordance with the "International Plumbing Code".

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Site Drains and Roof Drains

1. Jay R. Smith
2. Josam
3. Wade
4. Zurn
5. Watts

2.02 BASIC MATERIALS AND PRODUCTS

A. General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide materials and products complying with International and Uniform Plumbing Codes. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in storm drainage piping systems. Where more than one type of materials or products are indicated, selection is Installer's option.

B. Piping Specialties: Refer to Section 22 05 00 - Common Work Results for Plumbing.
C. Supports, Anchors and Seals: Refer to Section 22 05 29 - Hangers and Supports for Plumbing Piping.

#### 2.03 PIPE:

<table>
<thead>
<tr>
<th>Material</th>
<th>Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Polyvinyl Chloride Pipe (PVC) PSM SDR-35 or PS-46, ASTM D3034 or ASTM F789.</td>
<td>Outside sanitary sewers and outside storm sewers, 4” in dia. and larger beyond 5'-0” from building, as permitted by local code. Shall not be used in above ceiling air plenums.</td>
</tr>
<tr>
<td>B. Concrete sewer pipe extra strength bell and spigot ASTM C14, Table II.</td>
<td>Outside storm sewers up to and including 18” diameter, beyond 5'-0” from foundation.</td>
</tr>
<tr>
<td>C. Reinforced concrete sewer pipe, bell and spigot, ASTM C76.</td>
<td>Outside storm sewers over 18” diameter, beyond 5'-0” from foundation.</td>
</tr>
<tr>
<td>D. Cast iron soil pipe, service class, bell and spigot, asphalt coated, ASTM A74.</td>
<td>Below grade storm sewers, above ground storm.</td>
</tr>
<tr>
<td>E. Cast iron soil pipe, service class, no hub, asphalt coated CISPI 301 or ASTM A-888.</td>
<td>Below grade storm sewers, above ground storm as permitted by local code.</td>
</tr>
<tr>
<td>F. Polyvinyl Chloride Pipe (PVC) Schedule 40, DWV, ASTM D1785 and ASTM D2665.</td>
<td>Below grade storm sewers, above ground storm as permitted by local code.</td>
</tr>
</tbody>
</table>

#### 2.04 FITTINGS:

<table>
<thead>
<tr>
<th>Material</th>
<th>Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Material and strength of fitting for cast iron sewer pipe, clay sewer pipe and concrete sewer pipe shall conform to pipe as per ASTM Standards.</td>
<td></td>
</tr>
<tr>
<td>B. PVC pipe fittings (below grade sanitary sewer): Provide fittings produced and recommended for the service indicated by manufacturer of piping.</td>
<td></td>
</tr>
<tr>
<td>C. PVC DWV pipe fittings: ASTM D2665 DWV Schedule 40 socket type. Provide fittings produced and recommended for the service indicated by manufacturer of tubing. Solvent cements as per ASTM 2564.</td>
<td></td>
</tr>
</tbody>
</table>

#### 2.05 JOINTS:

<table>
<thead>
<tr>
<th>Material</th>
<th>Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Vitrified clay and concrete pipe: Pipe manufacturer's standard preformed pre-set plastic or rubber joint, installed in accordance with manufacturer's instructions. Acceptable manufacturers: Amvit, Tylox or Kent.</td>
<td></td>
</tr>
<tr>
<td>B. Cast iron bell and spigot soil pipe: Pack joints with oakum, fill with molten lead at one pouring, caulk solid flush with hub rim. If approved by Code, pre-set plastic or neoprene joint may be used, ASTM C 564.</td>
<td></td>
</tr>
<tr>
<td>C. Cast iron no-hub pipe: Coupling assembly tightened by torque wrench, CISPI 310, ASTM C 564.</td>
<td></td>
</tr>
</tbody>
</table>
D. PVC pipe fittings (below grade sanitary sewer): Listed compression type joints.
E. PVC DWV pipe: Solvent cement in accordance with ASTM D2564.

2.06 DRAINAGE PIPING PRODUCTS

A. General: Provide factory-fabricated drainage piping products of size and type indicated. Where not indicated, provide proper selection as determined by Installer to comply with the installation requirements and governing regulations.

B. Cleanout Plugs: Cast bronze or brass, threads complying with ANSI B2.1, countersunk head.
   1. Nickel-Bronze Top: Manufacturer's standard cast unit of pattern indicated:
      a. Pattern: Exposed flush type, standard non-slip scored or abrasive finish.
   2. Cast Iron Top: Manufacturer's standard cast unit of pattern indicated:
      a. Pattern: Exposed flush type, standard non-slip scored or abrasive finish.

C. Wall Cleanouts: Cast iron body adaptable to pipe with cast bronze or brass cleanout plug; stainless steel cover including screws.

D. Flashing Flanges: Cast iron watertight stack or wall sleeve with membrane flashing ring. Provide underdeck clamp and sleeve length as required.

2.07 ROOF DRAINS

A. General: Provide roof drains of size as indicated on drawings; and type, including features, as specified on the drawings.

B. Roof drain castings shall contain four (4) equally spaced clamping ring bolts. Drains, clamping rings, extensions, and under deck clamps shall be painted cast iron.

PART 3 - EXECUTION

3.01 INSPECTION

A. General: Examine areas and conditions under which storm drainage piping systems materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.02 INSTALLATION OF BASIC MATERIALS AND PRODUCTS

A. General: Install basic materials and products as required per manufacturer=s recommendations, International and Uniform Plumbing Codes, and as required to meet the intent of the documents.

B. Piping Specialties: Refer to Section 22 05 00 - Common Work Results for Plumbing.

C. Supports, Anchors and Seals: Refer to Section 22 0529 - Hangers and Supports for Plumbing Piping.
D. Lay building storm drains beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install required gaskets in accordance with manufacturer's recommendations for use of lubricants, cements and other special installation requirements. Clear interior of piping of dirt and other superfluous materials as work progresses. Maintain swab or drag in line and pull past each joint as it is completed. Place plugs in ends of uncompleted piping at end of day or whenever work stops. Where piping must cross footings, the piping shall cross under footings unless noted otherwise on the drawings.

E. Install storm water piping pitched to drain at minimum slope of 1/4" per foot (2%) for piping 3" and smaller and 1/8" per foot (1%) for piping 4" and larger.

3.03 STORM DRAINAGE PIPING

A. Install pipe for all storm drainage systems as indicated on drawings, as called for in other sections, and as specified herein.

B. Arrange and install piping approximately as indicated; straight, plumb, and as direct as possible; form right angles on parallel lines with building walls. Keep pipes close to walls and avoid interference with other trades. Locate groups of pipes parallel to each other; space at a distance to permit applying full insulation and to permit access for servicing valves. Most piping to be run in concealed locations unless indicated exposed, or in equipment rooms. Locate piping to avoid ductwork.

C. Install horizontal piping as high as possible without sags or humps so that proper grades can be maintained for drainage.

D. Check all piping for interference with other trades; avoid placing water pipes over electrical equipment.

E. Where rough-in is required for equipment furnished by others, verify exact rough-in dimension with owner or equipment supplier before roughing-in.

3.04 FIELD QUALITY CONTROL

A. Piping Tests: Test storm drainage piping in accordance with testing requirements of Division-22 Basic Materials and Methods, Section 22 00 10 - Plumbing General Provisions.

3.05 INSTALLATION OF DRAINAGE PIPING PRODUCTS

A. Cleanouts: Install in conductor piping and building storm drain piping as indicated, as required by Uniform Plumbing Code; at minimum intervals of 50' for piping 4" and smaller and 100' for larger piping; at base of each conductor; and where the line leaves the building. 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 through waterproof membrane.

3.06 INSTALLATION OF ROOF DRAINS

A. General: Install roof drains in accordance with manufacturer's written instructions and in locations indicated.
B. Coordinate flashing work required with the General Contractor and with work of roofing, waterproofing and adjoining substrate work.

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

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

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

END OF SECTION 22 14 13
SECTION 22 15 16 - FACILITY NATURAL GAS AND COMPRESSED AIR PIPING

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Contractor shall furnish all equipment, materials, tools, labor and supervision necessary to fabricate and install complete piping system as required by the drawings and this section.

1. Extent of natural gas piping work is indicated on drawings and schedules, and by requirements of this section.

2. Installation of valves for natural gas piping system is specified in other Division-22 sections and is included as work of this section.

B. Trenching and Backfill: Trenching and backfill required in conjunction with gas service piping is specified in applicable Division-22 sections, and is included as work of this section.

1.03 QUALITY ASSURANCE

A. NFPA Compliance: Fabricate and install natural gas systems in accordance with NFPA 54 "National Fuel Gas Code".

B. Utility Compliance: Fabricate and install natural gas systems in accordance with local gas utility company requirements.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Pressure Regulator:

1. Cashco
2. Fisher

B. Plug Valves

1. Homestead
2. Nordstrum

C. Ball Valves

1. Watts
2. Nibco
3. Apollo
4. Milwaukee
**2.02 BASIC MATERIALS AND PRODUCTS**

A. General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide materials and products complying with NFPA 54 where applicable; base pressure rating on natural gas piping system’s maximum design pressures. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in natural gas piping systems. Where more than one type of materials or products are indicated, selection is Installer’s option.

B. Piping Specialties: Refer to Section 22 05 00 - Common Work Results for Plumbing.

C. Supports, Anchors and Seals: Refer to Section 22 05 29 - Hangers and Supports for Plumbing Piping.

**2.03 PIPE:**

<table>
<thead>
<tr>
<th>Material</th>
<th>Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Black steel pipe Schedule 40, ASTM A53</td>
<td>Interior natural gas and compressed air piping.</td>
</tr>
<tr>
<td>C. High Density Polyethylene (PE), PE3408 ASTM D2837, ASTM D3035</td>
<td>Exterior below grade gas piping.</td>
</tr>
</tbody>
</table>

**2.04 FITTINGS:**

A. Steel Pipe:

1. Threaded pipe (2” dia and smaller): Malleable iron fittings, 125 pound standard flat band water pattern.
2. Welded pipe (2 1/2” dia and larger): Standard radius weld fittings and weld neck or slip-on flanges, same material and strength as pipe.

B. Polyethylene pipe fittings (gas service): Heat fusion fittings, provide fittings produced and recommended for the service indicated by manufacturer of piping.

**2.05 JOINTS**

A. Steel Pipe:

1. Threaded pipe (2” dia and smaller): Make joints using Teflon tape applied to male threads only. Cut pipe square, cut threads clean, remove burrs and ream ends to full size of bore. For fuel piping and lubricating oil piping, joint sealing material shall be resistant to petroleum products.
2. Welded pipe (2 1/2” dia and larger): Welding shall conform to welding section of ANSI-B31.3 “Code for Power Piping.”

B. Polyethylene pipe fittings (gas service): Heat fusion joints made in accordance with practices for the pipe service as recommended by manufacturer of piping.
2.06 NIPPLES AND UNIONS

A. All nipples shall conform to size, weight and strength of adjoining pipe. When length of unthreaded portion of nipple is less than 1-1/2", use extra strong nipple; do not use close nipples.

B. For pipe 2" and smaller, use screwed unions, for pipe 2-1/2" and over use flanged unions. For steel pipe use black or galvanized malleable iron unions, to conform to pipe with ground joint. Cast iron flanged unions gasket type. For threaded brass pipe, use bronze ground joint unions with octagon ends.

C. Install unions in the following locations so that a minimum amount of pipe need be disassembled:
   1. In by-pass around equipment, valves, and controls.
   2. In connections to equipment.
   3. Where indicated on drawings.

2.07 VALVES

A. Natural Gas: 2" and smaller: Two-piece full-port bronze ball valve, suitable for natural gas service, threaded ends.

B. Natural Gas: 2 1/2" to 6": Carbon steel or cast iron plug valve MSS SP-78, WOG (suitable for natural gas service) with flanged ends.

C. Natural Gas Meter Valve: Provide with tamper-proof operator.

PART 3 - EXECUTION

3.01 INSPECTION

A. General: Examine areas and conditions under which natural gas piping systems materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.02 INSTALLATION OF BASIC MATERIALS AND PRODUCTS

A. General: Install basic materials and products as per manufacturer’s recommendations, Uniform Plumbing Code, local code requirements, Utility Company requirements and as required to meet the intent of the document.

B. Natural Gas and Compressed Air Piping
   1. Install pipe for all natural gas systems as indicated on drawings, as called for in other sections, and as specified herein.
   2. Arrange and install piping approximately as indicated; straight, plumb, and as direct as possible; form right angles on parallel lines with building walls. Keep pipes close to walls and avoid interference with other natural gas items. Locate groups of pipes parallel to each other; space at a distance to permit applying full insulation and to permit access for servicing valves. Most piping to be run in concealed locations unless indicated exposed, or in equipment rooms. Locate piping to avoid ductwork.
   3. Install horizontal piping as high as possible without sags or humps so that proper grades can be maintained for drainage.
4. Check all piping for interference with other trades; avoid placing pipes over electrical equipment.

5. Where rough-in is required for equipment furnished by others, verify exact rough-in dimension with owner or equipment supplier before roughing-in.

6. Piping up to 2" diameter shall be screwed, piping 2-1/2" diameter and over shall be welded. Concealed gas piping shall be welded or otherwise installed as required per NFPA 54 and local code.

7. Plug each gas outlet, including valves, with threaded plug or cap immediately after installation and retain until continuing piping, or equipment connections are completed.

8. Install "Tee" fitting with bottom outlet plugged or capped, at bottom of pipe risers.

9. Install piping with 1/64" per foot (1/8%) downward slope in direction of flow.

10. Exposed outside pipe: Prime coat with appropriate lead oxide paint and apply finish enamel coat to match color of adjacent building material.

C. Valves

1. Locate valves for easy access and operation. Do not locate valves with stems below horizontal.

2. Sectional Valves: Install on each branch and riser, close to main, where branch or riser serves 2 or more natural gas terminals or equipment connections, and elsewhere as indicated.

3. Shutoff Valves: Install on inlet and outlet of each natural gas equipment item, and on inlet of each natural gas terminal, and elsewhere as indicated.

4. Drain Valves: Install on each natural gas equipment item located to completely drain equipment for service or repair. Install at base of each riser, at base of each rise or drop in piping system, and elsewhere where indicated or required to completely drain natural gas piping system.

D. Piping Specialties: Refer to Section 22 05 00 - Common Work Results for Plumbing.

E. Supports, Anchors and Seals: Refer to Section 22 05 29 - Hangers and Supports for Plumbing Piping.

F. Install specialties and accessories as indicated on drawings and in accordance with manufacturer's recommendations and applicable codes and standards.

3.03 INSTALLATION OF GAS SERVICE

A. General: Arrange with utility company to provide gas service to indicated location with shutoff at terminus. Consult with utility as to extent of its work, costs, fees, and permits involved. Pay such costs and fees; obtain permits.

B. Extend service pipe from utility’s terminus to inside building wall, under utility's direction.
3.04 INSTALLATION OF EQUIPMENT CONNECTIONS

A. General: Connect gas piping to each gas-fired equipment item, with drip leg and shutoff gas cock. Comply with equipment manufacturer's instructions.

3.05 FIELD QUALITY CONTROL

A. Piping Tests: Inspect, test, and purge natural gas systems in accordance with NFPA 54, and local utility company requirements.

3.06 ADJUSTING AND CLEANING

A. Cleaning and Inspecting: Clean and inspect natural gas systems in accordance with requirements of Division-22 Basic Mechanical Materials and Methods, Section 22 00 10 – Plumbing General Provisions.

3.07 SPARE PARTS

A. Valve Wrenches: Furnish to Owner, with receipt, 2 valve wrenches for each type of gas valve installed, requiring same.

END OF SECTION 22 15 16
SECTION 22 34 00 - FUEL-FIRED DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Extent of plumbing equipment work is indicated on drawings and provisions of this section, including schedules and equipment lists associated with either drawings or this section.

B. Types of plumbing equipment required for project include the following:

1. Water Heaters
2. Expansion Tanks

1.03 QUALITY ASSURANCE

A. UL and NEMA Compliance: Provide electric motors and electrical components required as part of plumbing equipment, which have been listed and labeled by Underwriters Laboratories and comply with NEMA standards.

B. NEC Compliance: Comply with National Electrical Code (ANSI/NFPA 70) as applicable to installation and electrical connections of ancillary electrical components of plumbing equipment.


D. AGA Labels: Provide water heaters which have been listed and labeled by American Gas Association.


1.04 SUBMITTALS

A. Product Data: Submit manufacturer's plumbing equipment specifications, installation and start-up instructions, and capacity and ratings, with selection points clearly marked.

B. Shop Drawings: Submit assembly type shop drawings indicating dimensions, weights, required clearances, and methods of assembly of all components.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Residential Gas-fired Water Heaters

2. Rheem-Ruud
3. State Industries
B. Residential Expansion Tanks

1. A.O. Smith
2. State
3. Rheem-Ruud

2.02 WATER HEATERS

A. Residential Gas-fired Water Heaters


2. Heater: Working pressure of 150 psi; 3/4" tapping for relief valve; magnesium anode rod; glass lining on internal surfaces exposed to water.

3. Safety Controls: Equip with automatic gas shutoff device to shut off entire gas supply in event of excessive temperature in tank; and pilot safety shutoff.

4. Combustion System: Equip with power venting system certified for power direct venting up to 40 equivalent feet on the intake vent arrangement and up to 40 equivalent feet on the exhaust vent arrangement, using standard PVC, class 160, schedule 40 or CPVC vent piping. Gravity direct vented or heaters that use room air for combustion are not acceptable equals. The water heater shall include a 6' plug-in power cord and provision for direct connection to a standard electrical outlet. Blower shall include pressure switches which will shut down power to the burner in case of vent system failure due to down drafts or vent blockage.

5. Jacket: Provide outer steel jacket with tank insulation and baked enamel finish.

6. Warranty: Furnish 1 year limited warranty for tank leakage.

7. Accessories: Provide brass drain valve; 3/4" relief valve; cold water dip tube.


B. Expansion Tanks

1. Furnish and install pre-charged steel expansion tanks as indicated on plans. Tanks shall have integral heavy duty Butyl rubber diaphragm, system connection(s), and a .302" - 32 charging valve connection (standard tire valve) to facilitate the on-site charging of the tank to meet system requirements. The tank shall be suitable for potable water.

PART 3 - EXECUTION

3.01 INSTALLATION OF WATER HEATERS

A. Gas-fired Water Heaters

1. General: Install gas-fired water heaters as indicated, in accordance with manufacturer's installation instructions, and in compliance with applicable codes.

2. Support: Set units and orient so controls and devices needing service and maintenance have adequate access. Level and plumb unit.
3. Gas Supply: Connect to gas line with drip leg, tee, gas cock and union; full size of unit inlet connection. Locate piping so as not to interfere with service of unit.

4. Piping: Connect hot and cold water piping to units with shutoff valves and unions.

5. Flue/Intake: Install according to manufacturer's recommendations to be consistent with sealed system or draft hood.

6. Start-Up: Start-up, test and adjust gas-fired water heaters in accordance with manufacturer's start-up instructions, and Utility Company's requirements. Check and calibrate controls, adjust burner for maximum efficiency.

7. Pressure and Temperature Relief: Route pipe to nearest indirect sanitary drain. Pipe size to match relief connection size.

END OF SECTION 22 34 00
PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Provide material, equipment, labor and supervision necessary for the plumbing fixture installation as required by the drawings and this section.

B. Fixtures, trim and accessories shall be of type and model numbers as scheduled on the drawings.

1.03 SUBMITTALS

A. Submit catalog cuts giving manufacturer's model numbers, fixture and rough-in dimensions, and construction material for each type of fixture, trim and accessory scheduled.

B. Furnish rough-in information that impacts other trades to General Contractor for distribution to other sub-contractors. This includes, but is not limited to, sink cut out templates, shower/tub framing dimension drawings, electrical power rough-in dimension drawings, etc.

1.04 QUALITY ASSURANCE

A. ANSI/NSF 372 Certification: All potable water supply piping and valves shall meet the requirements of ANSI/NSF 372 Certification, Drinking Water System Components, Lead Content.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Vitreous China and Cast Iron Enameled Fixtures

1. American Standard
2. Crane
3. Eljer
4. Kohler
5. Zurn
6. Sloan

B. Stainless Steel Sinks

1. Elkay
2. Just
3. Kohler

C. Trim

1. American Standard
2. Chicago Faucet
3. Delta
4. Eljer
5. Elkay
6. Kohler
7. T & S Brass Works
8. Sloan

D. Flush Valves
1. Sloan - Royal Series
2. Zurn - Z6000AV

E. Carriers
1. Jay R. Smith
2. Jonespec
3. Josam
4. Wade
5. Watts
6. Zurn

F. Fiberglass Tub and Shower Modules
1. Aqua Glass
2. Aquarius
3. Cedar Glass
4. Universal-Rundle
5. Crane
6. Aquatic
7. Best Bath

G. Closet Seats
1. Beneke
2. Church
3. Olsonite
4. Sperzel
5. Comfort Seats

H. Column Showers
1. Acorn
2. Bradley
3. Powers

I. Shower Valves
1. Leonard
2. Symmons
3. Delta
4. Kohler

J. Wash Fountains
1. Acorn
2. Bradley
K. Mop Sinks
   1. Fiat
   2. Mustee

L. Thermostatic Mixing Valves
   1. Leonard
   2. Powers
   3. Symmons
   4. Apollo
   5. Lawler

M. Digital Mixing Valves
   1. Armstrong

N. Garbage Disposals
   1. In-Sink-Erator

O. Wall Hydrants
   1. Woodford
   2. Prier

2.02 VITREOUS AND CAST IRON FIXTURES

A. Vitreous ware shall be non-absorbant, even color, unwarped, two-fired vitreous china, grade "A" as rated by the Bureau of Standards.

B. Enameled cast iron fixtures shall have the enamel fused with the iron to provide a hard acid-resisting enameled finish.

C. Vitreous and enamel fixtures shall be white, except where other colors are called for in the schedule.

D. Bath tubs shall have slip-resistant surface.

E. Fiberglass, gel-coat fixtures shall incorporate Microban antimicrobial protection.

2.03 STAINLESS STEEL SINKS

A. Stainless steel sinks shall be fabricated from 18 gauge nickel-bearing type 302 stainless steel, with satin finish, sound deadening treatment and 3/16" drop down ledge. Provide with channel and pull down clips to ensure tight seal between sink and countertop.

2.04 TRIM

A. Trim to include supply pipes, stop valves, faucets, tail pieces, strainers, waste and traps. Floor and wall plates shall be brass. Exposed trim shall be chrome plated.

B. Potable water supply piping and fixtures (excluding toilets, urinals, fill valves, flush valves, and shower valves) shall meet the certification requirements of ANSI/NSF 372 – Drinking Water System Components, Lead Content.
C. Stop valves shall be compression type with loose key control.

D. P-trap shall be adjustable 18 gauge tubular brass. Where offset P-traps are required for handicapped accessible lavatories, offset and P-trap shall be insulated with Handi Lav-Guard by Truebro, or equal. When supply risers are exposed, they shall be insulated with Handi Lav-Guard by Truebro, or equal.

E. Trim shall be considered "exposed" even when concealed behind base cabinets having doors.

F. Mixing valve, transformer, or piping under the counter shall be covered with Lav-Shield by Truebro or equal in areas where a cabinet does not cover them.

G. Water closet fixture carriers shall be heavy duty type with a minimum weight rating of 500 lbs.

2.05 DIGITAL MIXING VALVE

A. Temperature controller shall be controlled digitally via integrated circuit board technology designed to deliver blended water at a safe, accurate temperature. The mixing valve shall have a 2 line, 16 character display of delivered temperature with the option of deg. F or deg. C. Display shall also show the error codes and alarm conditions. The temperature controller shall be compliant with ASSE Standard 1017, CSA B125 and CE. Unit shall have lead free stainless steel/polymer construction.

B. General Performance:

1. The maximum water pressure drop shall not exceed 10 psi.
2. Outlet water temperature shall be controlled to within plus or minus 2 deg. F.
3. Operational water pressure shall be 20-125 psig.
4. Automatic shutoff of hot water flow upon cold water inlet supply failure.
5. Automatic shutoff of hot water flow in the event of power failure.
6. Programmable set point range of 100-158 deg. F.
7. Programmable 1st level hi/lo temperature alarm display.
9. Installation shall include a balancing valve with visible flow meter on circulated hot water side, Caleffi Model 132 or equal.

C. Digital Mixing Center: Shall consist of two or more digital mixing valves in pre-piped assembly, including isolation valves, strainers, and check valves. Complete assembly shall be lead free compliant.

PART 3 - EXECUTION

3.01 Install fixtures and make water supply, waste and vent connections as indicated on the drawings.

3.02 Set fixtures in center of stalls, between partitions where required. Dimensions for spacing shall be verified with General Contractor. Fixtures in ADA accessible stalls shall be installed with the flush valve handle to the open side of the stall, where applicable.

3.03 Setting shall be absolutely tight and rigid on proper ground. Use Miracle Adhesive Corporation Tub-Caulk or approved equal pointing material under all setting surfaces.

3.04 Wall hung fixtures shall be securely hung. All wall hung fixtures shall have carriers unless other mounting means are approved by Design Professional. Mounting heights shall be as indicated on Architectural elevations, and in accordance with the requirements of the ADA.
3.05 Chair carriers shall be securely braced to construction and shall be concealed with feet concealed in floor. Where feet cannot be concealed in floor, provide stub feet. Carriers for urinals shall have thrust bolts at bottom. Carriers for lavatories and electric water coolers shall have mounting plate type hanger or concealed arms as required by the fixture schedule. Carriers shall be coordinated with plumbing fixtures.

3.06 Fixtures shall be covered after they are set to prevent damage during the balance of construction. At the conclusion of work, the covering shall be removed and the fixtures properly cleaned.

3.07 Contractor shall be responsible for the protection of the fixtures until acceptance by Owner. Damaged fixtures shall be replaced at no additional cost to Owner.

3.08 Joints of lavatories with counter and/or wall, sinks with wall, urinals with wall and water closets with wall and/or floor shall be caulked with transparent silicone caulk by Contractor.

END OF SECTION 22 40 00
SECTION 22 47 00 - DRINKING FOUNTAINS AND WATER COOLERS

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Provide material, equipment, labor and supervision necessary for the plumbing fixture installation as required by the drawings and this section.
B. Fixtures, trim and accessories shall be of type and model numbers as scheduled on the drawings.

1.03 QUALITY ASSURANCE

A. ANSI/NSF 372 Certification: Drinking Fountains and Water Coolers shall meet the requirements of ANSI/NSF 372 Certification, Drinking Water System Components, Lead Content.

1.04 SUBMITTALS

A. Submit catalog cuts giving manufacturer's model numbers, fixture and rough-in dimensions, and construction material for each type of fixture, trim and accessory scheduled.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Electric Water Coolers
   1. Elkay
   2. Halsey Taylor
   3. Haws
   4. Oasis
   5. Sunroc/Western

B. Drinking Fountains
   1. Elkay
   2. Halsey Taylor
   3. Haws
   4. Oasis
   5. Sunroc/Western

2.02 ELECTRIC WATER COOLERS AND DRINKING FOUNTAINS

A. Refer to Plumbing Fixture Schedule for models and accessories.
B. Provide with factory wired 3-prong power cord(s) for unit power.

PART 3 - EXECUTION

3.01 Install fixtures and make water supply, waste and vent connections as indicated on the drawings.
3.02 Setting shall be absolutely tight and rigid on proper ground. Use Miracle Adhesive Corporation Tub-Caulk or approved equal pointing material under all setting surfaces.

3.03 Fixtures shall be securely hung. All wall hung fixtures shall have carriers unless other mounting means are approved by Design Professional.

3.04 Fixtures shall be covered after they are set to prevent damage during the balance of construction. At the conclusion of work, the covering shall be removed and the fixtures properly cleaned.

3.05 Contractor shall be responsible for the protection of the fixtures until acceptance by Owner. Damaged fixtures shall be replaced at no additional cost to Owner.

END OF SECTION 22 47 00
SECTION 23 00 10 - HVAC GENERAL PROVISIONS

PART 1 - GENERAL

1.01 GENERAL

A. Refer to Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements, which all apply to work under this section.

1.02 DESCRIPTION OF WORK

A. This section applies to all work under the HVAC contract. This shall include, but not necessarily be limited to, the following:

1. Piping Insulation
2. Ductwork for Air Distribution
3. Grilles, Registers, Diffusers and Dampers
4. Exhaust Fans and Ducts
5. Thermostats and Control Wiring
6. Insulation of Ducts and Plenums
7. Furnaces and Condensing Units and Refrigerant Piping
8. Unit Air Conditioners
9. Hot Water Boiler
10. Water Chillers
11. Terminal Heating and Cooling Units
12. Hydronic Piping

B. The work shall include all materials, equipment and labor required for complete and properly functioning HVAC systems.

C. Drawings for HVAC work are in part diagrammatic, intended to convey the scope of work and indicate general arrangement of equipment, piping and approximate sizes and locations of equipment and materials.

D. Where job conditions require reasonable changes in indicated locations and arrangements, make such changes without additional cost to Owner.

E. Because of the scale of the drawings, certain piping or items such as unions or fittings may not be shown, but where such items are required by other sections of the specifications, or where they are required by the nature of the work, they shall be furnished and installed.

F. All elements of the construction shall be performed by workmen skilled in the particular craft involved, and regularly employed in that particular craft.

G. All work shall be performed in a neat, workmanlike manner in keeping with the highest standards of the craft.

1.03 CODES AND STANDARDS

A. All work shall be done in accordance with the applicable portion of the following codes and standards:

1. International Mechanical Code
2. International Plumbing Code
3. International Building Code
5. National Fire Protection Association Standards (NFPA)
6. Local Utility Company Requirements
7. Local Codes, all trades
8. Standards of ASME, ASHRAE, NEMA, IEEE, AGA, SMACNA
9. Occupational Safety and Health Administration (OSHA)
10. Underwriters Laboratories, Inc. (U.L.)
11. Iowa Administrative Codes
12. Americans With Disabilities Act (ADA)

B. Contractors shall familiarize themselves with all codes and standards applicable to their work and shall notify Design Professional of any discrepancies between the design and applicable code requirements so that any conflicts can be resolved. Where two or more codes or standards are in conflict, that requiring the highest order of workmanship shall take precedence, but such questions shall be referred to Design Professional for final decision.

C. Where drawings or specifications call for workmanship or materials in excess of code requirements, a lower grade of construction will not be permitted.

1.04 REQUIREMENTS & FEES OF REGULATORY AGENCIES

A. Secure all required permits and pay for all inspections, licenses and fees required in connection with the HVAC work. Contractor shall post all bonds and obtain all licenses required by the State, City, County and Utility.

1.05 HVAC DRAWINGS

A. The HVAC drawings indicate in general the building arrangement only, Contractor shall examine construction drawings to familiarize himself with the specific type of building construction, i.e. type of structural system, floors, walls, ceilings, room finishes and elevations.

B. Drawings are intended to convey the scope of the work and to indicate the general arrangement and locations of ducts, piping and equipment.

C. Contractor shall layout his own work and shall be responsible for determining the exact locations for equipment and rough-ins and the exact routing of piping and ducts so as to best fit the layout of the work.

D. Contractor shall take his own field measurements for verifying locations and dimensions: scaling of the drawings will not be sufficient for laying out the work.

E. Because of the scale of the drawings, certain basic items such as pipe fittings and valves may not be shown, but where such items are required by code or by other sections of the specifications, such items shall be furnished and installed.

1.06 ACTIVE SERVICES

A. Contractor shall be responsible for verifying exact location of all existing services prior to beginning work in that area.

B. Existing active services, i.e., water, gas, sewer, electric, when encountered, shall be protected against damage. Do not prevent or disturb operation of active services which are to remain.

C. When active services are encountered which require relocation, Contractor shall make request to authorities with jurisdiction for determination of procedures.
D. Where existing services are to be abandoned, they shall be terminated in conformance with requirements of the authorities having jurisdiction.

1.07 SITE INSPECTION

A. Contractor shall inspect the site prior to submitting bid for work to familiarize himself with the conditions of the site which will affect his work and shall verify points of connection with utilities, routing of outside piping to include required clearances from any existing structures, trees or other obstacles.

B. Extra payment will not be allowed for changes in the work required because of Contractor's failure to make this inspection.

1.08 COORDINATION AND COOPERATION

A. It shall be Contractor's responsibility to schedule and coordinate his work with the schedule of the General Contractor so as to progress the work expeditiously, and to avoid unnecessary delays.

B. Contractor shall fully examine the drawings and specifications for other trades and shall coordinate the installation of his work with the work of the other contractors. Contractor shall consult and cooperate with the other contractors for determining space requirements and for determining that adequate clearance is allowed with respect to his equipment, other equipment and the building. Design Professional reserves the right to determine space priority of the contractors in the event of interference between piping, conduit, ducts and equipment of the various contractors.

C. Drawings and specifications are intended to be complimentary. Any work shown in either of them, whether in the other or not, shall be executed according to the true intent and meaning thereof, the same as if set forth in all. Conflicts between the drawings and the specifications or between the requirements set forth for the various contractors shall be called to the attention of Design Professional. If clarification is not asked for prior to the taking of bids, it will be assumed that none is required and that Contractor is in agreement with the drawings and specifications as issued. If clarification is required after the contract is awarded, such clarification will be made by Design Professional and his decision will be final.

D. Special care shall be taken for protection for all equipment. All equipment and material shall be completely protected from weather elements, painting and plaster until the project is substantially completed. Damage from rust, paint and scratches shall be repaired as required to restore equipment to original condition.

E. Protection of all equipment during the painting of the building shall be the responsibility of the Painting Contractor, but this shall not relieve Contractor of the responsibility for checking to assure that adequate protection is being provided.

F. Where the final installation or connection of equipment in the building requires Contractor to work in finished areas of the building, Contractor shall be responsible that such areas are protected and are not marred, soiled or otherwise damaged during the course of such work. Contractor shall arrange with the General Contractor for patching and refinishing of such areas which may be damaged in this respect.

1.09 OPENINGS, CUTTING AND PATCHING

A. Refer to Division 1 for additional cutting and patching information.
B. Piping, sleeves and ducts passing through all fire or smoke rated floors, roofs, walls, and partitions shall be provided with firestopping. Space between wall/floor and pipe, sleeve, and/or duct shall be sealed with UL listed intumescent fire barrier material equivalent to rating of wall/floor. Where piping, sleeves and ducts pass through floors, roofs, walls and partitions that are not fire or smoke rated, penetrations shall be sealed with grout or caulk.

C. New structure:
  1. Contractor will coordinate the placing of openings and lintels in the new structure as required for the installation of the HVAC work with the General Contractor.
  2. Contractor shall furnish to General Contractor the accurate locations and sizes for required openings, but this shall not relieve Contractor of the responsibility of checking to assure that proper size openings are provided. When additional cutting and patching is required due to Contractor's failure to coordinate this work, Contractor shall make arrangements for the cutting, patching, and painting required.

1.10 EXCAVATING AND BACKFILLING

A. Contractor shall do all excavating necessary for hydronic piping, gas piping, etc., and shall backfill trenches and excavations after work has been inspected. Care shall be taken in excavating that walls and footings and adjacent load bearing soils are not disturbed in any way, except where lines must cross under a wall footing. Where a line must pass under a footing, the crossing shall be made by the smallest possible trench to accommodate the pipe. Excavation shall be kept free from water by pumping if necessary.

B. Backfill about the structure shall be placed, when practical, as the work of construction progresses. Backfilling on or against concrete work shall be done only when directed. Backfilling of trenches shall progress as rapidly as the testing and acceptance of the finished sections of the work will permit. Backfill shall be in accordance with Division 31 Specifications.

1.11 MATERIALS AND EQUIPMENT

A. All materials and equipment shall be the standard product of a reputable U.S.A. manufacturer regularly engaged in the manufacture of the specified item. Where two or more units are required of the same item, they shall be furnished by the same manufacturer except where specified otherwise.

B. All material and equipment shall be installed in strict accordance with the manufacturer's recommendations.

C. The equipment specifications cannot deal individually with any minute items such as parts, controls, devices, etc., which may be required to produce the equipment performance and function as specified, or as required to meet the equipment guarantees. Such items, when required, shall be furnished as part of the equipment, whether or not specifically called for.

1.12 SUBMITTALS

A. Contractor shall furnish, to Design Professional, complete sets of shop drawings and other submittal data. Contractor shall review and sign shop drawings before submittal. Refer to Division 01 specifications for additional requirements.

B. Shop drawings shall be bound into sets and cover related items for a complete system as much as practical and shall be identified with symbols or "plan marks" used on drawings. Incomplete, piecemeal or unbound submittals will be rejected.
C. Submittals required by the various sections of the Project Manual include, but are not necessarily limited to those identified in the submittal schedule below.

D. After award of contract, Contractor shall provide a completed submittal schedule including dates that the submittals will be to Design Professional for review.

E. Submit required information on the following items:

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<th>SPEC SECTION</th>
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<th>DETAIL DWGS</th>
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<td>Expansion Fittings and Loops for HVAC Piping</td>
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<td>23 05 48</td>
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<tr>
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<td>Glycol Make-Up System</td>
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<td>Sys Fill Press Valve</td>
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<td>Auto Flow Ctrl Valve</td>
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<td>Triple Duty Valve</td>
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<tr>
<td>23 21 23</td>
<td>Hydronic Pumps</td>
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<td>X</td>
<td>X</td>
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<tr>
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<td>23 31 16</td>
<td>Non-Metal Ducts</td>
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<tr>
<td>23 33 00</td>
<td>Air Duct Accessories</td>
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<tr>
<td>23 34 16</td>
<td>Centrifugal HVAC Fans</td>
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</tr>
<tr>
<td>23 37 13</td>
<td>Diffusers, Registers and Grilles</td>
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<tr>
<td>23 38 13</td>
<td>Commercial Kitchen Exhaust Equipment</td>
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</tr>
</tbody>
</table>
### HVAC General Provisions

#### Spec Section 23 52 16
- **Equipment**: Condensing Boilers
- **Detail DWGS**: X
- **Prod Data**: X
- **Samples**: X
- **Install Methods**: X
- **O & M Manual**: X
- **Certificate of Demonstration**: X
- **Other (See Notes)**: 

#### Spec Section 23 62 00
- **Equipment**: Packaged Compressor and Condenser Units
- **Detail DWGS**: X
- **Prod Data**: X
- **Samples**: X
- **Install Methods**: X
- **O & M Manual**: X
- **Certificate of Demonstration**: X
- **Other (See Notes)**: 

#### Spec Section 23 72 00
- **Equipment**: Air-to-Air Energy Recovery Equipment
- **Detail DWGS**: X
- **Prod Data**: X
- **Samples**: X
- **Install Methods**: X
- **O & M Manual**: X
- **Certificate of Demonstration**: X
- **Other (See Notes)**: 

#### Spec Section 23 74 00
- **Equipment**: Packaged Outdoor HVAC Equipment
- **Detail DWGS**: X
- **Prod Data**: X
- **Samples**: X
- **Install Methods**: X
- **O & M Manual**: X
- **Certificate of Demonstration**: X
- **Other (See Notes)**: 

#### Spec Section 23 81 28
- **Equipment**: Ductless Split System Air Conditioners
- **Detail DWGS**: X
- **Prod Data**: X
- **Samples**: X
- **Install Methods**: X
- **O & M Manual**: X
- **Certificate of Demonstration**: X
- **Other (See Notes)**: 

#### Spec Section 23 82 20
- **Equipment**: Blower Coil Units
- **Detail DWGS**: X
- **Prod Data**: X
- **Samples**: X
- **Install Methods**: X
- **O & M Manual**: X
- **Certificate of Demonstration**: X
- **Other (See Notes)**: 

#### Spec Section 23 82 39
- **Equipment**: Unit Heaters
- **Detail DWGS**: X
- **Prod Data**: X
- **Samples**: X
- **Install Methods**: X
- **O & M Manual**: X
- **Certificate of Demonstration**: X
- **Other (See Notes)**: 

#### Spec Section 23 83 16
- **Equipment**: Radiant Floor Heating System
- **Detail DWGS**: X
- **Prod Data**: X
- **Samples**: X
- **Install Methods**: X
- **O & M Manual**: X
- **Certificate of Demonstration**: X
- **Other (See Notes)**: 

### Notes:
1. Submit test reports as described in specification section.
2. Submit borehole log and record drawings.

### 1.13 Operation and Maintenance Manuals

**A.** Operation and maintenance manuals shall be submitted to Design Professional in duplicate upon completion of the job. Refer to Division 01 specifications for additional information.

**B.** Submit manuals in duplicate upon completion of the job. Manuals shall be bound in a three ring hard-backed binder. Front cover and spine of each binder shall have the following lettering done:

```
OPERATION AND MAINTENANCE MANUAL FOR HVAC SYSTEMS
(PROJECT NAME)
(LOCATION)
(DATE)

SUBMITTED BY
(NAME AND ADDRESS OF CONTRACTOR)
```

**C.** Provide a master index at the beginning of manual showing items included. Use plastic tab indexes for sections of manual. Each section shall contain the following information for equipment furnished under this contract:

1. Equipment and system warranties and guarantees.
2. Installation instructions.
3. Operating instructions.
5. Spare parts identification and ordering list.
6. Local service organization, address, contract and phone number.
7. Shop drawings with reviewed stamp of Design Professional and Contractor shall be included, if applicable, along with the items listed above.
8. Reports of all tests and demonstrations including certificate of owner instruction, testing and balancing report, etc.

1.14 TESTS AND DEMONSTRATIONS

A. Tests Required: Piping shall be tested and proved tight under the following static pressures. Pressure shall be maintained for four (4) hours.

<table>
<thead>
<tr>
<th>System</th>
<th>Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydronic Piping</td>
<td>150 psi (water)</td>
</tr>
<tr>
<td>Steam Piping</td>
<td>150 psi (water)</td>
</tr>
<tr>
<td>Refrigeration Piping:</td>
<td></td>
</tr>
<tr>
<td>Precharged Lines</td>
<td>Charge and operate unit. Check for leaks with electronic leak detector.</td>
</tr>
<tr>
<td>Fuel Piping</td>
<td>100 psi air pressure or 150% of operating pressure (whichever is greater)</td>
</tr>
</tbody>
</table>

B. All systems shall be tested by Contractor and placed in proper working order prior to demonstrating systems to Owner. Contractor shall submit a report to Design Professional citing dates, times, pressures, and results of all tests performed.

1.15 TRAINING AND DEMONSTRATIONS

A. Prior to acceptance of the HVAC installation, Contractor shall provide to Owner, or his designated representatives, all comprehensive training on essential features and functions of all systems installed, and shall instruct Owner in the proper operation and maintenance of such systems.

1. Provide adequate notice to Owner as to when instruction will be conducted so appropriate personnel can be present.
2. Prepare the instruction format for a minimum of four Owner Representatives.

B. Equipment training for Owner:

1. Manufacturer's representatives shall provide instruction on each major piece of equipment. Contractor shall provide instruction on all other equipment.
2. Training sessions shall use the printed installation, operation and maintenance instruction materials included in the O&M manuals and emphasize preventative maintenance and safe operating procedures.
3. Training shall be performed by qualified factory trained technicians.
4. HVAC Contractor shall attend all sessions performed by the manufacturer's representative and shall add to each session any special information relating to the details of installation of the equipment as it might impact the operation and maintenance.
5. Equipment training shall occur as soon as possible after start up of the equipment and shall include hands-on operation. Training shall be provided for equipment listed in the table below.
C. System training for Owner:

1. HVAC and Temperature Controls Contractors shall jointly conduct system operating training. These sessions shall include:

   a. HVAC system overview.
   b. System wide start-up.
   c. Operation of control system.
   d. Function of each component.
   e. System operating procedures in all possible modes.
   f. Programming procedures.
   g. Shut-down and maintenance procedures.
   h. Emergency procedures.

D. The following are minimum requirements for Owner instruction:

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Hours (Note 1)</th>
<th>Presented By</th>
<th>Others Present</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>23 00 10</td>
<td>HVAC System (Excluding Equipment)</td>
<td>8</td>
<td>Mech. Contractor</td>
<td>T.C. Contractor</td>
<td>Note 2</td>
</tr>
<tr>
<td>23 21 13</td>
<td>Hydronic Piping - Water Treatment</td>
<td>4</td>
<td>Manufacturer’s Representative</td>
<td>Contractor</td>
<td></td>
</tr>
<tr>
<td>23 21 23</td>
<td>Hydronic Pumps</td>
<td>4</td>
<td>Contractor</td>
<td></td>
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<tr>
<td>23 5X XX</td>
<td>Central Heating Equip.</td>
<td>4</td>
<td>Manufacturer’s Representative</td>
<td>Contractor</td>
<td></td>
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<tr>
<td>23 7X XX</td>
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<td>4</td>
<td>Contractor</td>
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</tr>
<tr>
<td>23 34 XX</td>
<td>Fans</td>
<td>2</td>
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<td>23 62 00</td>
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<td>4</td>
<td>Contractor</td>
<td></td>
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<tr>
<td>23 38 13</td>
<td>Commercial Kitchen Exhaust Equipment</td>
<td>4</td>
<td>Contractor</td>
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<tr>
<td>23 81 28</td>
<td>Split System Air Conditioners</td>
<td>2</td>
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<td></td>
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<tr>
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<td>Unit Heaters</td>
<td>2</td>
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<td>23 83 16</td>
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<td>4</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>23 09 00</td>
<td>Temperature Control System</td>
<td>40</td>
<td>T.C. Contractor</td>
<td></td>
<td>Note 3</td>
</tr>
</tbody>
</table>

1. Any unused hours shall be used at Owner's discretion during the first year of occupancy.
2. System training shall include, but not be limited to, valve locations, system routing, and air/water flow patterns, system start-up/shut-down/emergency procedures.
3. Training shall occur in several sessions over the course of the first year of operation. A minimum of four separate dates are required for temperature controls, two dates for chillers.

E. Contractor shall submit to Design Professional a certificate, signed by Owner stating the date, time and persons instructed and that the instruction has been completed to Owner’s satisfaction. An example of a certificate form is as follows:
CERTIFICATE OF SYSTEM DEMONSTRATION

This document is to certify that Contractor has demonstrated the hereafter listed systems to Owner's representatives in accordance with the Contract documents and that the instruction has been completed to Owner's satisfaction.

A. Project:

B. System(s):

C. Contractor's representatives giving instruction and demonstration:

<table>
<thead>
<tr>
<th>NAMES</th>
<th>DATE</th>
<th>HOURS</th>
</tr>
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<tbody>
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</table>

D. Owner's representatives receiving instruction:

Owner: ____________________________

<table>
<thead>
<tr>
<th>NAMES</th>
<th>DATE</th>
<th>HOURS</th>
</tr>
</thead>
<tbody>
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</table>

Acknowledgement of demonstration:

E. Contractor's Representative: ____________________________
signature

date

Owner's Representative: ____________________________
signature

date
1.16 SUBSTITUTIONS
A. Refer to Divisions 00 and 01.
B. Where substitutions are approved, Contractor assumes all responsibility for physical dimensions and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of the substitution.

1.17 ACCEPTABLE MANUFACTURERS
A. In most cases, equipment specifications are based on a specific manufacturer's type, style, dimensional data, catalog number, etc. Listed with the base specification, either in the manual or on the plan schedules are acceptable manufacturers approved to bid products of equal quality. These manufacturers are encouraged to submit to Design Professional at least 8 days prior to the bid due date drawings and catalog numbers of products to be bid as equals.
B. Manufacturers who do not submit prior to bidding, run the risk of having the product rejected at time of shop drawing submittal. Extra costs associated with replacing the rejected product shall be the responsibility of Contractor and/or the manufacturer.
C. If Contractor chooses to use a manufacturer listed as an equal, it shall be his responsibility to assure that the manufacturer has complied with the requirements in 'A' above. Contractor shall assume all responsibility for physical dimensions (including accessibility for maintenance), operating characteristics, and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of using the alternate manufacturer.
D. Where a model or catalog number is provided, it may not be inclusive of all product requirements. Refer to additional requirements provided on the plans or in the specifications as required. Similarly, there may be additional requirements included in the model or catalog number that are not specifically stated. These requirements shall also be met.

1.18 GUARANTEE
A. The entire HVAC system including all sub-systems shall be guaranteed against defect in materials and installation for a minimum of one year from substantial completion or beneficial occupancy whichever occurs earlier. Any malfunctions which occur within the guarantee period shall be promptly corrected without cost to Owner. This guarantee shall not limit or void any manufacturer's express or implied warranties.

1.19 COMPLETION
A. Systems, at time of completion, shall be complete, efficiently operating, non-hazardous and ready for normal use by Owner.
B. Contractor shall clean up and remove from the site all debris, excess material and equipment left during the progress of this contract at job completion.

1.20 CLEANING
A. Prior to assembly of pipe and piping components, all loose dirt, scale, oil, and other foreign matter on internal and exterior surfaces shall be removed by means consistent with good piping practices. During fabrication and assembly, slug and weld splatter shall be removed from both internal and external pipe joints by preening, chipping, and wire brushing.
B. At the conclusion of the construction, the entire system of piping and equipment shall be cleaned internally. Prior to flushing erected piping surfaces, Contractor shall disconnect all instrumentation and equipment and open wide all valves.

C. All temporary labels, stickers, etc., shall be removed from all fixtures and equipment. Name plates, ratings, instruction plates, etc., shall not be obscured by paint, insulation, or placement of units.

D. Heating and air conditioning equipment shall be thoroughly cleaned and clean filters installed.

### 1.21 ELECTRICAL WORK

A. Electrical work and equipment provided by HVAC Contractor shall include the following:

1. Starters and disconnects for motors of HVAC equipment, but only where specifically indicated to be furnished integrally with equipment.
2. Wiring from motors to disconnect switches or junction boxes for motors of HVAC equipment, but only where specifically indicated to be furnished integrally with equipment.
3. Electrical heating coils and similar elements in HVAC equipment.
4. All control wiring in accordance with the requirements of Division 26.

B. Electrical Contractor shall provide all power wiring for HVAC equipment, including services for motors and equipment furnished by the HVAC contractor. Motor and equipment locations are shown on the electrical drawings.

C. Electrical Contractor shall make final connections for all motors and equipment furnished by the HVAC contractor.

D. Electrical Contractor shall furnish safety disconnects and starters for all motors and equipment furnished by the HVAC contractor (unless specifically indicated to be furnished integrally with the equipment), so as to make service complete to each item of equipment.

E. Contractor shall consult with Electrical Contractor prior to conduit rough-in and shall verify with him the exact locations for rough-ins, and the exact size and characteristics of the services required, and shall provide Electrical Contractor a schedule of electrical loads for the equipment furnished by him. These schedules will be used for sizing services, disconnects, fuses, starters and overload protection.

F. Refer to Division 23 Controls section for control system wiring. Control wiring shall be done in accordance with the requirements of Division 26.

G. All conduit installed for control wiring shall be blue. Labeled conduit will not be accepted.

H. All control wiring shall be in blue conduit.

### 1.22 TEMPORARY UTILITIES

A. Refer to Division 01 for specific requirements concerning temporary utilities.

B. Under no circumstances shall the building HVAC equipment be used for temporary heat, cooling or ventilation during construction prior to Owner acceptance of the building at substantial completion.

END OF SECTION 23 00 10
SECTION 23 05 00 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.01 GENERAL

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. This section includes the following:

1. Sleeves
2. Escutcheons
3. Fire Stopping
4. Guards
5. Wall Access Doors
6. Equipment Pads

PART 2 - PRODUCTS

2.01 SLEEVES

A. Sleeves passing through non-load bearing walls and partitions shall be galvanized sheet steel with lock seam joints of minimum gauges as follows:

1. For pipes 2-1/2" and smaller - 24 gauge
2. For pipes 3" to 6" - 22 gauge
3. For pipes over 6" - 20 gauge

B. Sleeves passing through load bearing walls, concrete beams, fireproof walls, foundations, footings and waterproof floors shall be Schedule 40 steel pipe or cast iron pipe.

C. Sleeves are not required in masonry walls which are core drilled or walls of drywall construction, except where partition is a firestop, smokestop, or side of air plenum.

D. Sleeves for insulated piping shall be of sufficient internal diameter to take pipe and insulation and to allow for free movement of pipe. Waterproof sleeves shall be of sufficient internal diameter to take pipe and waterproofing material.

E. In finished areas where pipes are exposed, sleeves shall be terminated flush with wall, partitions and ceilings, and shall extend 1/2" above finished floors. Extend sleeves 1" above finished floors in areas likely to entrap water and fill space between sleeves and pipe with graphite packing and caulking compound.

F. Sleeves passing through membrane waterproofing or lead safe shall be provided with flashing, furnished and installed by General Contractor, extending 12" beyond sleeve in all directions; flashing shall be secured and sealed to membrane or lead safe and shall be sealed to sleeve and caulked watertight. Sleeves passing through roof shall be installed in same manner except sleeves shall extend to 6" above roof.

G. For exterior walls below grade, sleeves shall be cast iron. Space between sleeve and pipe shall be sealed with modular rubber links tightened with bolts (Link-Seal or equal). Waterproofing of pipe penetrations in exterior walls shall be coordinated with waterproofing contractor.
2.02 ESCUTCHEONS

A. Provide chrome plated escutcheons at each sleeved opening into finished spaces. Escutcheons shall fit around insulation or around pipe when not insulated; outside diameter shall cover sleeve. Where sleeve extends above finished floor, escutcheon shall be high cap type and shall clear sleeve extension. Secure escutcheons or plates to sleeve but not to insulation with set screws or other approved devices.

2.03 FIRESTOPPING

A. Piping, conduit, sleeves and ducts passing through all fire or smoke rated floors, roofs, walls, and partitions shall be provided with firestopping. Space between wall/floor and pipe, conduit, sleeve, and/or duct shall be sealed with UL Listed intumescent fire barrier material equivalent to rating of wall/floor.

2.04 WALL ACCESS DOORS

A. When HVAC Contractor provides any equipment requiring periodic servicing which will be concealed by non-accessible architectural construction, HVAC Contractor shall provide a flush access door. The access door shall be equal to a Karp DSC-214M Universal access door for non-rated construction or KRP-150FR for fire rated construction. Other approved manufacturers include Nystrom, Acudor, and Access Panel Solutions, with model applicable to the specific construction involved.

B. Access doors in fire rated construction shall be fire rated and have U.L. label. Refer to Architectural/General Construction plans for fire ratings.

C. Construction

1. Door and trim shall be 13 gauge steel, frames shall be 16 gauge steel.
2. Trim shall be of one piece construction.
3. Finish shall be prime coat of rust inhibitive baked grey enamel.
4. Hinges shall be concealed, offset, floating hinge.
5. Locks shall be flush, screwdriver operated with stainless steel cam-and-studs.

PART 3 - EXECUTION

3.01 SLEEVES

A. Install sleeves for all piping passing through floors, roof, walls, concrete beams and foundations as required by this section.

3.02 ESCUTCHEONS

A. Install escutcheons for all pipes entering finished spaces.

3.03 GUARDS

A. Where exposed insulated piping extends to floor, provide sheet metal guard around insulation to extend up from floor 48". Guard to be galvanized sheet not less than 26 gauge.

3.04 ACCESS DOORS

A. Install access doors per manufacturer’s recommendations.
3.05 CONCRETE EQUIPMENT PADS

A. Provide equipment housekeeping pads for all floor mounted equipment. Anchor equipment to
   concrete equipment pads according to equipment manufacturer’s recommendations.

1. Construct concrete bases of dimensions indicated or as required to be 4 inches larger in
   both directions than supported unit. Pads to be a minimum of 4” in height unless noted
   otherwise.

2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise
   indicated, install dowel rods on 18-inch centers around the full perimeter of the base.

3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete
   base, and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use supported equipment manufacturer’s setting
   drawings, templates, diagrams, instructions, and directions furnished with items to be
   embedded.

5. Install anchor bolts according to manufacturer’s recommendations and to elevations
   required for proper attachment to supported equipment.

6. Use 3000-psi compressive strength concrete with #3 rebar 12” O.C.

END OF SECTION 23 05 00
SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.01 GENERAL

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer’s factory or shipped separately by equipment manufacturer for field installation.

1.03 SUBMITTALS

A. Submit for all motors provided.

B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.

C. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.

D. Manufacturer’s Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.

PART 2 - PRODUCTS

2.01 GENERAL

A. Comply with NEMA MG1 unless noted otherwise.

B. Constant Speed Motors: Minimum 1.15 service factor; rated at 40 deg. C. ambient temperature with 90 deg. C. temperature rise (Class B insulation).

C. Motors Used with Variable Frequency Controllers: Inverter duty rated, Class F insulation (minimum). Windings shall be copper magnet with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.

D. Multiple speed motors: Multiple windings.

E. Motor Efficiency: Premium efficiency as defined in NEMA MG1.

F. Peak instantaneous current: Maximum 130% of full-load.

G. All motors shall be provided as required for motor orientation within equipment.

H. Horsepower ratings shall be adequate for operating the connected loads continuously in the prevailing ambient temperatures in areas where the motors are installed, without exceeding the NEMA standard temperature rises for the motor insulations.
I. Motor designs, as indicated by the NEMA code letters, shall be coordinated with the connected loads to assure adequate starting and running torques.

J. Motor Enclosures:
   1. Shall be the NEMA types shown on the drawings for the motors.
   2. Where the types of motor enclosures are not shown on the drawings, they shall be the NEMA types which are most suitable for the environmental conditions where the motors are being installed. Motors located outdoors to be totally enclosed weatherproof epoxy-sealed type.
   3. Thoroughly clean and paint the enclosures at the factory with manufacturer's prime coat and standard finish.

K. Additional requirements for specific motors, as indicated in other sections, shall also apply.

2.02 SINGLE PHASE POWER

A. Capacitor start motors starting torque shall be three times full load torque and starting current shall be less than five times full load current.

B. Pull-up Torque: Up to 350 percent of full load torque.

C. Breakdown Torque: Approximately 250 percent of full load torque.

D. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

E. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.

F. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.03 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Starting Torque: Between 1 and 1-1/2 times full load torque.

B. Starting Current: Six times full load current.

C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.


E. Insulation System: NEMA Class B or better.

F. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.

G. Motor Frames: NEMA Standard T-Frames of steel, aluminum or cast iron with end brackets of cast iron or aluminum with steel inserts.

H. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter.
I. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum AFBMA 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

PART 3 - EXECUTION (Not Used)

END OF SECTION 23 05 13
SECTION 23 05 16 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this Section.

1.02 DESCRIPTION OF WORK

A. Provide material, equipment, labor and supervision necessary to install expansion joints and pump connections as required by the drawings and this section.

B. Any expansion indicated per plans has been based on steel pipe. If Contractor should choose to use an alternate approved material, he shall be responsible for any resulting changes in expansion.

1.03 SUBMITTALS

A. Submit manufacturer's catalog cuts and schedules for all mechanical joints and pump connectors.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Expansion Compensation Products

1. Flexonics
2. Metraflex
3. Victaulic
4. Minnesota Flexible
5. Keflex
6. Twin City Hose
7. Tri-State Industries
8. Mason Industries

2.02 HYDRONIC MAINS

A. Mechanical Expansion Compensator for 2" diameter and smaller steel pipe: Externally pressurized, all metal stainless steel bellows, carbon steel shroud and end fittings, internal guides and internal anti-torque device. 150 psi minimum design pressure. Metraflex Model HP.

B. Mechanical Expansion Compensator for 2" diameter and smaller copper pipe: Externally pressurized, all bronze with either stainless steel or bronze bellows, brass or copper shroud and end fittings, internal guides and internal anti-torque device. 150 psi minimum design pressure. Metraflex Model HPMF.

C. Mechanical Expansion joint for 2-1/2" diameter and larger: Self equalizing, ring controlled bellows, carbon steel shroud and end fittings, internal guides and internal anti-torque device. 300 psi design temperature. Metraflex Model MC.

D. Mechanical Expansion Joints for Grooved Pipe: Typical installation shall be approved by submittal.
E. Pipe Guides: Pre-insulated alignment guides, Keflex series CP.

**2.03 STEAM MAINS**

A. Mechanical Expansion joint for 2-1/2" diameter and larger: Self equalizing, ring controlled bellows, carbon steel shroud and end fittings, internal guides and internal anti-torque device. 300 psi design temperature. Metraflex Model MC.

**PART 3 - EXECUTION**

3.01 Provide for taking up expansion in hot water and steam mains and risers by means of installing loops, bends and mechanical expansion joints.

3.02 Use swing or swivel joints for connections from mains to risers and from risers to coils and equipment connections. Cold spring pipe during installation at points of bends or offsets.

3.03 Install anchoring as required for controlling expansion. Structural members for anchoring shall be firmly embedded or fastened into building members and shall withstand force of pipe expansion without straining building structure.

3.04 Where expansion joints and/or loops are installed, piping shall be properly guided and anchored as recommended by expansion joint manufacturer. For chilled water systems or two-pipe heating/cooling systems, all pipe alignment guides to be preinsulated by factory. Keflex Series CP.

**END OF SECTION 23 05 16**
PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this Section.

1.02 DESCRIPTION OF WORK

A. Provide material, equipment, labor and supervision necessary to install meters and gauges as required by the drawings and this section.

1.03 SUBMITTALS

A. Submit manufacturer's catalog cuts showing complete descriptive data.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Thermometers

1. Weiss 9VU335 (Base Specification)
2. Taylor
3. Weksler
4. U.S. Gauge
5. Trerice

B. Gauges (For Water or Steam)

1. Weiss Series 4CTS (Base Specification)
2. Dwyer
3. Taylor
4. Weksler
5. U.S. Gauge
6. Trerice

2.02 THERMOMETERS

A. 9" "Adjust-Angle" industrial thermometer complete with double thick glass front, red reading, separable socket and arranged so the unit can be set at any required angle front to back or left to right during or after installation. Range 30-240 deg. F for hot water, 0-120 deg. F for chilled water, and 0-120 deg. F for heat pump water.

2.03 GAUGES

A. Weiss Series 4" liquid filled compound pressure-vacuum gauge with snubber, stainless steel case, white dial, 1/4" male NPT.

1. Hydronic systems – typical range to be 30" vacuum to 100 lb. pressure. For systems with a fill pressure greater than 30 psi (e.g. multi-story buildings, refer to Expansion Tank Schedule), extend range as necessary to account for fill pressure plus scheduled pump head.
2. Low pressure steam - 30" vacuum to 30 lb. pressure.
3. Medium and High pressure steam - 30" vacuum to 1-1/2 times the system pressure for.
4. For outside applications use silicon filled gauge.

PART 3 - EXECUTION

3.01 Install thermometers in discharge and return piping at boilers, heat exchangers, and chillers, at each supply and return connection for large heating and cooling coils and at other points as indicated on the drawings.

3.02 Install gauge for each pump, mounted on 1/4" galvanized steel pipe manifold connected to the suction and discharge of the pump, with the needle valves in the manifold on each side of the gauge, so that the gauge may be opened to either the suction or discharge pressure.

3.03 Install gauges on boiler and heat exchanger headers, at pressure reducing valves and at other points as indicated on drawings.

END OF SECTION 23 05 19
PART 1 - GENERAL

1.01 RELATED WORK
A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK
A. Provide material, equipment, labor and supervision necessary to install valves as required by the drawings and this section.

1.03 SUBMITTALS
A. Submittal data shall include physical dimensions, construction materials, and pressure and temperature ratings.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS
A. Gate Valves, Globe Valves, and Check Valves
   1. NIBCO
   2. Powell
   3. Milwaukee
   4. Watts
   5. Apollo Valves
B. Lugged Body Butterfly Valves
   1. NIBCO
   2. ABZ
   3. Milwaukee
   4. Watts
   5. Apollo Valves
C. Grooved Body Butterfly and Swing Check Valves
   1. Victaulic
   2. Milwaukee
   3. NIBCO
D. Ball Valves
   1. Watts LFB-6080/6081
   2. Milwaukee BA-400S/BA450S
   3. NIBCO T/S 585-70-66
   4. Apollo 77C-140/240
E.  Polypropylene and/or PVDF Ball Valves
   1. R&G Sloan - PPRO-Seal
   2. ASAHF
   3. Enfield
   4. ASAHI/American
   5. NIBCO/Chemtrol S61TBV/S62TBV and/or S65TBV

F. Refrigerant Ball Valves
   1. Apollo 79-700 Series
   2. Mueller Streamline Cyclomaster Series

G. All valves of same type shall be of the same manufacturer unless otherwise specified in this section or on the drawings.

H. Model numbers in valve schedule based on NIBCO, unless noted otherwise.

2.02 VALVE CONSTRUCTION

A. Gate valves shall have solid tapered wedge, except where otherwise specified. Valves on steam service 4" and larger shall have 1/2" (minimum) bypass valve and piping.

B. Globe valves shall have renewable composition discs as recommended by manufacturer for intended service, or renewable bevel seats and metal discs. Valves on steam service 4" and larger shall have 1/2" (minimum) bypass valve and piping.

C. Check Valves: Horizontal swing type with bronze seat and composition of bronze disc as approved; body of same material, pressure rating, screwed or flanged and finish as adjoining globe or gate valve. Check valves 2" and larger installed at outlet of pumps shall be spring loaded silent type.

D. Ball Valves 2-1/2" and smaller: Full port, bronze two-piece with stainless steel ball, teflon seats and stuffing box ring, vinyl insulated lever handle.

E. Butterfly Valves 3" and larger: ASTM A536 ductile iron body with aluminum bronze disc, EPDM or BUNA N seat, 416 stainless steel stem with gear box operator and extended neck.

F. Refrigerant Ball Valves 2-5/8" and smaller: Brass two-piece full port with chrome plated ball, teflon seats, triple sealed stem, and brass cap. Valve shall be hermetic welded.

2.03 VALVE SCHEDULE

A. Furnish valves as per the following schedule:

<table>
<thead>
<tr>
<th>Service</th>
<th>Valve type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat pump water, cooling/heating water,</td>
<td>Ball - 2-1/2&quot; and smaller, Apollo 77C</td>
</tr>
<tr>
<td>pressures up to 200 psi, temperatures from</td>
<td>Butterfly - 2-1/2&quot; and larger, LD2000-3/5</td>
</tr>
<tr>
<td>40 deg. F to 250 deg. F.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Swing Check - 2&quot; and smaller, 413B</td>
</tr>
<tr>
<td></td>
<td>2-1/2&quot; and larger, F918</td>
</tr>
<tr>
<td></td>
<td>Silent Check – 2&quot; and larger,</td>
</tr>
<tr>
<td></td>
<td>Temp &lt; 180 deg. F. W-910-W, Or W-920-W</td>
</tr>
<tr>
<td></td>
<td>Temp &gt; 180 deg. F. F-910-B, W-910-B</td>
</tr>
</tbody>
</table>
Steam, condensate and boiler feed, up to 125 psi and below 450 deg. F. (150# Class)
Gate - 2" and smaller, T-134
2-1/2" and larger, F-617O
Check - 3" and smaller, T-433
4" and larger, Fig. 559, F-918
Globe - 2" and smaller, Fig. 2600, T-235-Y
2-1/2" and larger, Fig. 241, F-718-B

Refrigerant lines
Ball – 2-5/8" and smaller, Apollo 79-700
B. Valves installed on all systems with insulated piping shall be provided with valve handle extensions and/or extended neck design to facilitate installation of insulation and make handles operable without damage to the insulation.

C. Grooved Piping System: At Contractor’s option, if mechanical grooved piping system is utilized, the butterfly valves for HVAC applications may be Victaulic Series VIC-300 and swing check valves for HVAC applications may be Victaulic Series 712 swing check valves, except in pump discharge. Check valves in pump discharge shall be as specified previously.

PART 3 - EXECUTION

3.01 Install valves as indicated on the drawings and as called for in other sections.

3.02 Install valves in equipment rooms to provide easy access to valve. Each valve installed 8'-0" above the floor shall be provided with chain operator. Bottom of chain operator shall be 7'-0" above floor.

3.03 Check valves shall not be installed in vertical runs of piping unless they are specifically designed for vertical operation.

3.04 Valves shall not be installed in vertical sections of steam pipe.

3.05 Gate valves shall be installed in horizontal pipes with the valve stem in the vertical up position. Rotate valve stem only as allowed by the manufacturer’s installation instructions.

END OF SECTION 23 05 23
SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this Section.

1.02 DESCRIPTION OF WORK

A. Provide materials, equipment, labor and supervision necessary to install hangers, supports, anchors, guides and seals as required by the drawings and this section.

B. Types of supports, anchors and seals specified in this section include the following:

1. Horizontal-Piping Hangers and Supports.
2. Vertical-Piping Clamps.
3. Hanger-Rod Attachments.
5. Saddles and Shields.
7. Anchors.

1.03 QUALITY ASSURANCE

A. Code Compliance: Comply with applicable plumbing and mechanical codes pertaining to product materials and installation of supports, anchors and seals.

B. UL and FM Compliance: Provide products which are Underwriters Laboratories listed and Factory Mutual approved.

C. ANSI Compliance: All supports and parts shall conform to the latest requirements of the ANSI Code for Pressure Piping B31.1.0 except as supplemented or modified by the requirements of this specification.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, acceptable manufacturers are as follows, with catalog numbers based on Grinnell:

1. Anvil International
2. B-Line
3. Elcen
4. Unistrut Building Systems
5. Grinnell

B. Pipe support systems shall secure pipes in place, prevent pipe vibration, provide vertical adjustment for maintaining required grades, and provide for expansion and contraction.

C. Pipe hangers shall be capable of supporting the pipe in all conditions of operation. They shall allow free expansion and contraction of the piping, and prevent excessive stress resulting from transferred weight being induced into the pipe or connected equipment.
D. Wherever possible, pipe attachments for horizontal piping shall be pipe clamps.

E. Wherever possible, structural attachments shall be beam clamps.

F. All rigid hangers shall provide a means of vertical adjustment after erection.

G. Hanger rods shall be subject to tensile loading only. At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit swing.

H. Where horizontal piping movements are greater than 1/2 inch, or where the hanger rod angularity from the vertical is greater than 4 degrees from the cold to hot position of the pipe, the hanger pipe and structural attachments shall be offset in such manner that the rod is vertical in the hot position.

I. Hangers shall be designed so that they cannot become disengaged by movements of the supported pipe.

J. Where supports are attached to concrete or other structural members, care shall be taken to prevent damage or weakening of the structural members.

K. Where concrete inserts are used, it shall be the Contractor's responsibility to accurately locate and attach inserts to concrete forms.

L. Hangers and supports that are in direct contact with copper piping shall be copper plated or have nonmetallic coating for electrolytic protection.

PART 3 - EXECUTION

3.01 INSTALLATION - HORIZONTAL PIPE SUPPORT

A. Steel and copper pipe shall be supported at a maximum span of 10 feet for all pipe sizes, with hanger rods sized accordingly for total supported weight. For 1/2 in. copper tube, maximum spacing shall be 8 feet.

B. Plastic pipe (PVC, CPVC, polyethylene, etc.) shall be supported at a maximum span of 4 feet for all pipe sizes, with hanger rods sized accordingly for total supported weight.

C. In addition to the above specified spacings, install additional hangers at change in pipe direction and at concentrated loads, large valves, strainers, etc.

D. When two or more pipes are to be run parallel together, they may be supported on trapeze type hangers. Trapeze bar angles or channels and hanger rods shall be of sufficient size with required spacing to support the particular group of pipes.

E. For suspending hanger rods from brackets attached to walls; use welded steel brackets, Fig 194 for loads up to 750 lbs; Fig. 195 for loads up to 1,500 lbs; Fig. 199 for loads up to 3000 lbs.

F. Exterior refrigerant piping shall be supported with steel angle or steel channel strut supports as detailed on the drawings.

G. Where pipes are to be racked along walls, use malleable iron one-hole clamp, Fig. 126 for pipes up to 3". For pipes larger than 3", use steel channel strut pipe rack.

H. Where pipes are to be supported from floor, use unistrut pipe stand with post base. Unformed concrete will not be permitted.
3.02 INSTALLATION - VERTICAL PIPE SUPPORTS

A. Support vertical steel and copper pipe at every other floor line.

B. In addition to the above, support vertical pipes at base of riser with base fitting set on concrete or block pier, or by hanger located on horizontal connection close to riser.

C. Where pipe sleeves extend above floor, place pipe clamps at ceiling below and support clamp extensions from inserts or other approved attachment.

3.03 PIPE ATTACHMENTS

A. For horizontal steel pipe, use adjustable carbon steel clevis, Fig. 260, for pipes up to 30".

B. For horizontal copper pipe and tube, use copper plated adjustable carbon steel clevis, Fig. CT-65.

C. When thermal expansion for horizontal pipe is in excess of 1/2" axially as indicated on the drawing, use adjustable steel yoke pipe roll, Fig. 181, or pipe roll stand, Fig. 177.

3.04 INTERMEDIATE ATTACHMENTS

A. Hanger rods: use carbon steel single or double end threaded, Figs. 140 and 253 as required. Continuous threaded rod, Fig. 146, may be used wherever possible. Contractor may at his option cut and thread rod on the job site.

B. Chain, wire or perforated strap hangers will not be permitted. One pipe shall not be suspended from another pipe.

C. Hangers shall be supported from appropriate structural members. In no case shall hangers be supported from ductwork, cable trays, piping, or other equipment. Existing hangers and supports shall not be used as supports for new hangers unless specifically designed as such, or additional loadings have been confirmed to be acceptable for existing supports.

3.05 STRUCTURAL ATTACHMENTS

A. For attaching steel or copper plated hanger rods to reinforced concrete; use black carbon steel concrete inserts, Fig. 285 for loads up to 400 lbs., Fig. 281 for loads up to 1200 lbs. or suitable drilled inserts equal to Ramset/Red Head - Trubolt wedge anchor, Ramset/Red Head Epcon system or Hilti Kwik Bolt II anchor.

B. For attaching steel hanger rods to structural steel beams, use malleable iron C-clamps, Fig. 87, with retaining clip for loads up to 500 lbs.; Fig. 229 with extension piece for loads up to 1,365 lbs. For copper plated hanger rods, use copper plated malleable iron C-clamps, Fig. CT-88, with hardened cup point set screw, for loads up to 400 lbs.

C. For attaching steel hanger rods to wood structural members, use malleable iron ceiling flange pipe threaded, Fig. 128 for loads up to 480 lbs., Fig. 153 for loads up to 1270 lbs. For copper plated hanger rods, use copper plated malleable iron ceiling flange, Fig. CT-128R for loads up to 180 lbs.

D. Under no circumstances shall hangers be attached to metal roof deck.
3.06 PIPE AND DUCT COVERING PROTECTION

A. Hangers and supports for insulated cold piping and ductwork shall not injure or pierce insulation. Provide insulation protection shields or saddles for piping, Fig. 160, 161, 162, 163, 164, 165, 165A, 166A, or 167 in conjunction with hanger or roll device.

3.07 ROOF MOUNTED PIPING AND EQUIPMENT

A. Roof mounted equipment, not specified to be mounted on roof curbs shall be installed on equipment mounting rails specifically designed for that purpose or as shown on plans.

B. Roof mounted piping and ductwork shall be mounted on a pipe support system equal to B-Line C-Port.

END OF SECTION 23 05 29
SECTION 23 05 48 - VIBRATION CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Conditions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Extent of vibration isolation work required by this section is indicated on drawings and schedules, and/or specified in other Division-23 sections.

B. All HVAC equipment over one horsepower, unless otherwise noted shall be isolated from the structure by means of vibration and noise isolators.

C. Where isolator type and deflection are not shown, the related equipment shall be isolated in accordance with the 2011 ASHRAE Handbook - HVAC Applications, Chapter 48.

D. Types of vibration isolation products specified in this section include the following:

1. Precompressed Molded Fiberglass Isolators.
2. Elastomeric Isolators.
5. Isolation Hangers.
7. Concrete Inertia Bases.
8. Isolation Rail Systems.
10. Flexible Pipe Connectors.

E. Vibration isolation products furnished as part of factory-fabricated equipment are specified as part of the equipment assembly in other Division-23 sections.

F. Refer to other sections of these specifications for equipment foundations, hangers, sealants, gaskets and other work related to vibration isolation work.

1.03 QUALITY ASSURANCE

A. Product Qualification: Provide each type of vibration isolation unit produced by specialized manufacturer, with not less than 5 years' successful experience in production of units similar to those required for project.

1. The materials and systems specified in this Section shall all be provided by the Contractor, from a single vibration isolation materials manufacturer to assure single responsibility for the performance of all isolation materials.

1.04 SUBMITTALS

A. The isolator manufacturer's submittal shall include the complete design for required isolation and bases, and a tabulation of the design data including O.D., free and operating heights of the isolators.
PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Vibration Isolation Products

1. Kinetics Noise Control, Inc.
2. Vibration Eliminator Co., Inc.
3. Vibration Mountings and Controls, Inc.
4. Mason Industries

B. The following item specifications apply to the corresponding Type numbers used in the Vibration Isolation Schedule. Model types are based on the 2011 ASHRAE Handbook - HVAC Applications, Chapter 48.

2.02 ISOLATION MATERIALS AND SUPPORT UNITS

A. Springs: All springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. All springs except internal nested springs shall have an outside diameter not less than 0.8 of the compressed height of the spring. Ends of springs shall be square and ground for stability. Laterally stable springs shall have kx/ky ratios of at least 0.9. All springs shall be fully color-coded to indicate capacity – color striping is not considered adequate.

B. Corrosion Protection: All springs shall be powder-coated enamel. Housings shall be galvanized, powder-coated enamel, or painted with rust-resistant paint. Hot-dipped galvanized housings shall be provided as indicated on the Schedule.

C. Base Types

1. Type A Bases - no base required. Isolators may be attached directly to the supported equipment.
2. Type B Bases - Steel Equipment Bases: Bases shall be of welded construction with cross members to form an integral support platform. Structural steel members shall be designed to match supported equipment.
   a. Vibration bases for fans shall have adjustable motor slide rails as indicated on their Schedule, and shall accommodate motor overhang.
   b. Bases for exterior use shall be painted or hot-dipped galvanized for complete corrosion resistance.
   c. Minimum clearance under steel equipment bases shall be 25mm (1”).
3. Type C Bases - Concrete Inertia Bases: Inertia bases shall be of welded steel construction with concrete in-fill supplied by the installing contractor on site and shall incorporate reinforcing bars, spaced 300 mm (12”) maximum on centers each way.
   a. Inertia bases for pumps shall be of sufficient size to accommodate supports for pipe elbows at pump suction and discharge connections (if this information has been provided for configuration).
   b. Inertia bases for fans shall include motor slide rails as indicated on their Schedule.
   c. The weight of each inertia base shall be at least (1.5 times(x)) to the weight of the equipment mounted thereon or sufficient to lower the center of gravity to or below the isolator support plane.
   d. Inertia bases shall be a minimum of 150 mm (6”) thick.
4. Type D Bases: Isolation Rail System, consisting of two parallel aluminum rail systems with continuous neoprene air and water seal, incorporating steel spring isolators designed for one inch static deflection, all fabricated to be installed over the roof curb system, and provide continuous support for the isolated equipment.
D. Isolator Types

1. Type 1 Isolator - Rubber Pads and Glass Fiber Pads:
   a. Isolation pads shall be single ribbed or crossed, double ribbed elastomer-in-shear pads, in combination with steel shims when required, having minimum static deflections as tabulated. All pads shall be true elastomer-in-shear using alternately higher and lower ribs to provide effective vibration isolation, and shall be molded using 2500 PSI (176 kg/cm²) tensile strength, oil resistant compounds with no color additives. Pads shall be 45 to 65 durometer and designed to permit 60 or 120 PSI (4.2 or 8.4 kg/cm²) loading at maximum rated deflections. When two isolation pads are laminated, they shall be separated by, and bonded to, a galvanized steel shim plate. Neoprene vibration isolators shall have minimum operating static deflections as shown on the Vibration Isolation Schedule or as indicated on the project bid documents, not exceeding published load capabilities.
   b. Fiberglass continuous support material shall be high-density matrix of compressed molded fiberglass; individually coated with a flexible, moisture-impervious elastomeric membrane, designed to allow controlled air movement in the fiber media. It shall be manufactured in such a way that the pumping action of air between fibers provides viscous damping, reducing motion caused by transient shock and vibration. The material shall be non-corrosive, non-combustible, non-absorbent, and resists rust, ozone, mildew and fungus, vermin proof and it shall not shrink, swell, or decompose. Isolation characteristics of the media shall be constant over a temperature range of -40°F to 250°F (40°C to 121°C).

2. Type 2 Isolators - Rubber Mounts and Hangers:
   a. Vibration isolators shall be neoprene, molded from oil-resistant compounds, with cast-in-top steel load transfer plate for bolting to supported equipment, and a bolt-down plate with holes provided for anchoring to supporting structure. Top and bottom surfaces shall have non-skid ribs. Neoprene vibration isolators shall have minimum operating static deflections as shown on the Vibration Isolation Schedule or as indicated on the project documents but not exceeding published load capabilities.
   b. Vibration isolators with maximum static deflection requirements under the operating load conditions not exceeding .40” shall be hangers consisting of an elastomer-in-shear insert encased in a welded steel bracket and provided with a stamped load transfer cap. The elastomer insert shall be neoprene, molded from oil resistant compounds and shall be color coded to indicate load capacity and selected to operate within its published load range. The hanger bracket shall be designed to carry a 500% overload without failure and to allow a support rod misalignment through a 30-degree arc without metal-to-metal contact or other short circuit.
3. **Type 3 Isolators - Spring Isolators and Hangers:**
   a. Vibration isolators shall be free standing, un-housed, laterally stable springs wound from high strength spring steel. Springs shall have a lateral stiffness greater than 0.8 times the rated vertical stiffness and shall be designed to provide up to 50% overload capacity. Springs shall be supported either with a neoprene cup or a metal base plate complete with a ribbed neoprene pad, minimum 6 mm (0.25") thick, bonded to the base plate. Springs shall be selected to provide operating static deflections as required. Springs shall be color coded or otherwise identified to indicate load capacity. In capacities up to 5,000 lbs., springs shall be replaceable. In capacities over 5,000 lbs., springs shall be welded to the top and bottom load plate assemblies. Springs shall be assembled between a top and bottom steel load plate. The upper load plate shall be provided with a steel leveling bolt lock nut and washer for attachment to the supported equipment. The lower load plate shall have a non-skid noise isolation pad bonded to the bottom and have provisions for bolting the isolator to the supporting structure.
   b. Vibration isolators for suspended equipment, with minimum static deflection requirement exceeding .4", shall be hangers consisting of a free-standing, laterally stable steel spring and elastomeric washer in series, assembled in a stamped or welded steel bracket. The spring element shall meet all the specified characteristics described in above. The stamped or welded hanger bracket shall meet all the specified characteristics described above. Shall also be fitted with a self-centering load cap for the hanger rod.

4. **Type 4 Isolators - Restrained Spring Isolators:** Vibration isolators for equipment which is subject to load variations and large external or torquing forces shall consist of large diameter laterally stable steel springs assembled into formed or welded steel housing assemblies designed to limit vertical movement of the supported equipment. Springs shall be supported either with a neoprene cup of a metal base plate complete with a ribbed neoprene pad, minimum 6 mm (0.25") thick, bonded to the base plate. Housing assembly shall be formed or fabricated steel members and shall consist of a top-load plate complete with adjusting and leveling bolts, vertical restraints, isolation washers and a bottom plate with non-skid noise stop pads and holes provided for anchoring to supporting structure. Housing shall be hot dipped galvanized. Spring elements shall meet all the specified characteristics described above.

5. **Type 5 Isolators - Thrust Restraints:** Provide in pairs. Locate on centerline of fan if possible. Bridge the flexible duct connector. Spring elements shall meet all the specified characteristics described above.

E. **Flexible Duct Connectors:**
   1. Flexible neoprene or canvas connections of approved construction shall be provided in the ductwork adjacent to all air moving units.
   2. High velocity ductwork, for a distance of 50 feet from high pressure fans, shall be isolated from the structure by means of Type 2 Hangers described herein.

F. **Flexible Piping Connectors:**
   1. Piping over one inch diameter and piping three supports away from rotating or reciprocating HVAC equipment shall be isolated from the structure by means of vibration and noise isolators.
   2. Suspended piping shall be isolated with Type 2 Hangers described herein.
3. Floor mounted piping shall be isolated with Type 2 Isolators (spring mounts) described herein.
4. Flexible members shall be incorporated in the piping adjacent to all reciprocating and/or rotating equipment and pumps. Flexible pipe connectors not required at in-line pump installations.
5. See Section 23 21 23 – Hydronic Pumps for pump connector specifications.

PART 3 - EXECUTION

3.01 PERFORMANCE OF ISOLATORS

A. General: Comply with minimum static deflections recommended by the American Society of Heating, Refrigerating and Air-Conditioning Engineers, including definitions of critical and noncritical locations, for selection and application of vibration isolation materials and units as indicated.

B. Manufacturer's Recommendations: Except as otherwise indicated, comply with manufacturer's recommendations for selection and application of vibration isolation materials and units.

3.02 APPLICATIONS

A. General: Apply types of vibration isolation materials and units indicated at locations shown or scheduled. Selection is Installer's option where more than one type is indicated.

3.03 INSTALLATION

A. General: Except as otherwise indicated, comply with manufacturer's instructions for 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. Anchor and attach units to substrate and equipment as required for secure operation and to prevent displacement by normal forces, and as indicated.

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

E. Bond flanges of flexible duct connectors to ducts and housings to provide airtight connections. Seal seams and penetrations to prevent air leakage.

F. Flexible Pipe Connectors: Install on equipment side of shutoff valves, horizontally and parallel to equipment shafts wherever possible.

3.04 EXAMINATION OF RELATED WORK

A. Installer of vibration isolation work shall observe installation of other work related to vibration isolation work, including work connected to vibration isolation work; and, after completion of other related work (but before equipment startup), shall furnish written report to Contractor listing observed inadequacies for proper operation and performance of vibration isolation work. Report shall cover, but not necessarily be limited to the following:

1. Equipment installations (performed as work of other sections) on vibration isolators.
2. Piping connections including flexible connections.
3. Ductwork Connections including provisions for flexible connections.
4. Passage of piping and ductwork which is to be isolated through walls and floors.

B. Do not start up equipment until inadequacies have been corrected in manner acceptable to vibration isolation Installer.

END OF SECTION 23 05 48
SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Extent of identification work required by this section is indicated on drawings and/or specified in other Division-23 sections.

B. Type of identification devices specified in this section include the following:
   1. Painted identification materials
   2. Plastic pipe markers
   3. Plastic tape
   4. Valve tags

C. Identification furnished as part of factory fabricated equipment, is specified as part of the equipment assembly in other Division-23 sections.

1.03 QUALITY ASSURANCE

A. ANSI Standards: Comply with ANSI A13.1 for lettering size, colors, and viewing angles of identification devices.

1.04 SUBMITTALS

A. Schedules: Submit valve schedule for each piping system, formatted in an Excel spreadsheet with a digital copy provided to the Owner along with a printed copy on 8-1/2" x 11" paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in margin of schedule. In addition, furnish extra copies for Maintenance Manuals.

B. Labeling Nomenclature: Submit list indicating system types with appropriate nomenclature to be provided on the pipe labels. Where possible, match to system labels on drawings.

PART 2 - PRODUCTS

2.01 IDENTIFICATION MATERIALS

A. General: Provide manufacturer’s standard products of categories and types required for each application as referenced in other Division-23 sections. Where more than one single type is specified for an application, selection is Installer's option, but provide single selection for each product category.

B. Painted Identification Materials:
   1. Stencils: Standard fiberboard stencils, prepared for required applications with letter sizes generally complying with recommendations of ANSI A13.1 for piping and similar applications, but not less than 3/4" high letters for access door signs and similar operational instructions.
2. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray-can form and grade.

3. Identification Paint: Standard identification enamel of colors indicated, or, if not otherwise indicated for piping systems, comply with ANSI A13.1 for colors.

C. Plastic Pipe Markers:


2. Small Pipes: For external diameters not greater than 6" (including insulation if any), provide full-band pipe markers extending 360 degrees around pipe at each location, fastened by one of the following methods:
   a. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
   b. Adhesive lap joint in pipe marker overlap.
   c. Laminated or bonded application of pipe marker to pipe (or insulation).
   d. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4" wide full circle at both ends of pipe marker, tape lapped 1-1/2".

3. Large Pipes: For external diameters of 6" and larger (including insulation if any), provide either full-band or narrow strip-type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:
   a. Laminated or bonded application of pipe marker to pipe (or insulation).
   b. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2" wide; full circle at both ends of pipe marker, tape lapped 3".
   c. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.

4. Lettering: Manufacturer's standard pre-printed nomenclature which best describes piping system in each instance, as selected by Design Professional in cases of variance with names as shown or specified.

5. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as a separate unit of plastic.

D. Plastic Tape:

1. General: Manufacturer's standard color-coded pressure-sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.
   a. Width: Provide 1-1/2" wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6", 2 1/2" wide tape for larger pipes.
   b. Color: Comply with ANSI A13.1, except where another color selection is indicated.

E. Valve Tags:

1. Brass Valve Tags: Provide polished brass valve tags with stamp-engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 7/16" high, and with 3/16" hole for fastener. Tag thickness 0.040 inches.
   a. Provide 2" diameter tags, except as otherwise indicated.
   b. Fill tag engraving with black enamel.
2. Plastic Valve Tags: Provide red heavy plastic tag with 7/16” white embossed sequenced numbers.

3. Valve Tag Fasteners: Manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks or heat sealed braided copper wire of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

F. Name Plates:

1. General: Provide manufacturer’s standard preprinted plastic, brass, or aluminum with stamped, engraved or embossed letters.

2. Lettering:
   a. Large Equipment: 1 1/2” lettering as appropriate.
   b. Small Equipment: 3/4” lettering as appropriate.

3. Attachments: Mounting holes and screws, pressure sensitive adhesive backing, or solid brass chain.

2.02 LETTERING AND GRAPHICS

A. General: Coordinate names, abbreviations and other designations used in HVAC identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of HVAC systems and equipment.

   1. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Boiler No. 3, Air Supply No. 1H, Standpipe F12).

PART 3 - EXECUTION

3.01 APPLICATION AND INSTALLATION

A. General Installation Requirements:

   1. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish including valve tags, install identification after completion of covering and painting if any. Install identification prior to installation of acoustical ceilings and similar concealment.

B. Ductwork Identification:

   1. Access Doors: Provide stenciled or plastic-laminate type signs on each access door in ductwork and housings, indicating purpose of access (to what equipment) and other maintenance and operating instructions, and appropriate safety and procedural information.

C. Piping System Identification:

   1. General: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:
      a. Stenciled markers, including color-coded background band or rectangle, and contrasting lettering of black or white. Extend color band or rectangle 2” beyond ends of lettering.
b. Plastic pipe markers, with application system as indicated under "Materials" in this section.
c. Stenciled markers, black or white for best contrast, wherever continuous color-coded painting of piping is provided.

2. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations. Install markers such that lettering is visible from floor.
   a. Near each valve and control device.
   b. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
   c. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
   d. At access doors, manholes and similar access points which permit view of concealed piping.
   e. Near major equipment items and other points of origination and termination.
   f. Spaced intermediately at maximum spacing of 20' along each piping run with a minimum of one marker in each room.
   g. On piping above removable acoustical ceilings.

D. Valve Identification:

1. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, and shut-off valves at terminal devices and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.

E. Equipment Identification:

1. General: Provide equipment identification for all equipment including air handling units, terminal units, fans, pumps, boilers, heaters, control panels, heat exchangers, condensing units, and chillers.

2. Labeling: All equipment shall be labeled as per construction document plan marks or as designated by Owner.

3. Provide identification by means of nameplates or stenciled painting as appropriate.
   a. For equipment with factory furnished casing, identification shall be by adhesive fixed name plates.
   b. Field insulated items, such as heat exchangers may be identified by plastic pipe markers or stenciled lettering.

F. Filter Identification:

1. All filter locations shall be provided with a permanent filter label indicating the size and quantity of filters required at that location. The label shall be legible, durable (phenolic or equivalent), and easily viewed when changing the filter. All filters shall be a standard size.

END OF SECTION 23 05 53
SECTION 23 05 93 - TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Extent of testing, adjusting and balancing work is indicated by requirements of this section, and also by drawings and schedules, and is defined to include, but is not necessarily limited to, air distribution systems and associated equipment and apparatus of HVAC work. The work consists of setting speed and volume (including pulley changes as required) adjusting facilities provided for systems, recording data, conducting tests, preparing and submitting reports, and recommending modifications to work as required by contract documents.

B. Immediately after the draft balancing report is complete the balancing contractor, controls contractor, and mechanical contractor shall schedule a meeting with the Design Professional and the owner to discuss every item in the report page by page. All items that do not meet engineering requirements or could not physically be balanced as required shall be coordinated and resolved prior to this meeting. No payments for balancing shall be requested or made until this meeting is held.

C. Component types of testing, adjusting and balancing specified in this section includes the following as applied to HVAC equipment:

1. Air Systems:
   a. Blower Coil Units
   b. Rooftop Air Handling Units
   c. Energy Recovery Units
   d. Exhaust Fans
   e. Ductwork Systems
   f. Diffusers and Grilles

2. Water Systems:
   a. Pumps
   b. Coils
   c. HVAC Piping Systems
   d. Domestic Hot Water Recirculating System

D. The Heating and Air Conditioning Contractor shall provide a complete and operating HVAC system and shall cooperate with the balancing agency by:

1. Installing balancing dampers as required by the Drawings and Specifications and requested by the Testing and Balancing Contractor.
2. Putting complete system into operation during duration of balancing period.
3. Providing up-to-date set of Drawings and advising immediately of any changes made to the system during construction.
4. Providing labor and equipment and cost of performing corrections, such as dampers, belts, etc., as required without undue delay.
5. Providing complete submittal information for all HVAC equipment, complete with pertinent engineering information.
1.03 REFERENCES

A. Associated Air Balance Council (AABC) - National Standards for Field Measurement and Instrumentation, Total System Balance.


C. National Environmental Balancing Bureau (NEBB) - Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

1.04 QUALITY ASSURANCE

A. Tester: A firm with at least 3 years of successful testing, adjusting and balancing experience on projects with testing and balancing requirements similar to those required for this project, who is not Installer of system to be tested and is otherwise independent of project.

B. TAB Agency Qualification: Current membership in AABC or certification by NEBB or SMACNA.

C. Test Equipment Criteria: The basic instrumentation requirements and accuracy/calibration required by AABC, National Standards or by NEBB Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems.

D. All testing and balancing contractors are to be approved by the Design Professional before bidding. The contractors approved to date are:

1. Precision Test and Balance
   Clive, Iowa
   (515) 288-2332

2. Systems Management and Balancing
   Waukee, Iowa
   (515) 987-2825

3. River Place Technologies
   East Moline, Illinois
   (309) 796-0800

4. Integrity Testing and Balancing
   Madrid, Iowa
   (515) 250-6055

1.05 JOB CONDITIONS

A. Do not proceed with testing, adjusting and balancing work until work has been completed and is operable. Ensure that there is no latent residual work still to be completed.

B. Do not proceed until work scheduled for testing, adjusting and balancing is clean and free from debris, dirt and discarded building materials.

1.06 SUBMITTALS

A. TAB Agency Qualifications: Submit names and qualifications of company officers and job supervisor. Submit list of proposed test equipment and sample report format indicating all measurements to be taken. These shall be submitted to and reviewed by Design Professional prior to commencing work.
B. The test-and-balance report shall be complete with logs, data, and records as required herein. All logs, data, and records shall be typed on white bond paper and bound. The report shall be certified accurate and complete by the balancing agency's certified test-and-balance engineer.

C. Three (3) copies of the test-and-balance report are required and shall be submitted to Design Professional.

D. The report shall contain the required data in a format selected by Balancing Contractor.

E. Report shall include the following information: (For all references to "design", specific information from shop drawings shall be incorporated.)

1. Air Moving Equipment:
   a. Location
   b. Manufacturer and Model
   c. Supply, return and exhaust, air flow, design and actual
   d. Outside air flow, design and actual (where applicable)
   e. Inlet, discharge, and total static pressure, design and actual
   f. Full static pressure profile with measurements between all components through unit.
   g. Fan RPM, design and actual
   h. Static pressure across the coil section with the face and bypass damper in both the face and bypass positions (where face and bypass dampers are provided).

2. V-Belt Drive:
   a. Identification/location
   b. Required driven RPM
   c. Driven sheave, diameter and RPM
   d. Belt, size and quantity
   e. Motor sheave, diameter and RPM

3. Duct Traverse:
   a. System zone/branch
   b. Duct size and area
   c. Velocity and airflow, design and actual
   d. Duct static pressure
   e. Air temperature and correction factor (if applicable)

4. Air Monitoring Station Data:
   a. Identification/location
   b. System
   c. Size and area
   d. Velocity and airflow, design and actual

5. Room Air Distribution Test Sheet:
   a. Air terminal number
   b. Room number/location
   c. Terminal type and size
   d. Area factor
   e. Velocity, design and actual
   f. Air flow, design and actual
   g. Percent of design air flow
   h. Air outlet differential pressure (for underfloor plenums)

6. Pump Data:
   a. Identification/number
   b. Manufacturer and model
7. Central Station Cooling and Heating Coil Data:
   a. Identification/number
   b. Location and service
   c. Air flow, design and actual
   d. Entering and leaving air DB and WB temperatures, design and actual
   e. Water flow and pressure drop, design and actual
   f. Entering and leaving water temperature, design and actual
   g. Air pressure drop, design and actual
   h. Differential pressure across balancing valves.

8. Terminal Unit Heating and Cooling Coil Data
   a. Identification/number
   b. Manufacturer and model
   c. Entering and leaving DB temperature, design and actual
   d. Entering and leaving water temperature, design and actual
   e. Water flow, design and actual
   f. Differential pressure across balancing valves.

9. Water Flow Measuring Station:
   a. Identification/station
   b. Manufacturer and model
   c. Location
   d. Size
   e. Flow rate and pressure drop, design and actual
   f. Station calibrated setting

10. Electric Motors:
   a. Manufacturer (1/4 hp and larger only)
   b. HP/BHP, design and actual
   c. Phase, voltage, amperage; design and actual
   d. Service factor
   e. Starter size, rating, heater elements (as applicable)

11. Radiant Floors and Snow Melt:
   a. Circuit number and size
   b. Circuit flow rate, design and actual
   c. Thermal images of entire radiant area after balancing is complete

PART 2 - PRODUCTS

2.01 PATCHING MATERIALS

A. Except as otherwise indicated, use same products as used by original Installer for patching holes in insulation, ductwork and housings which have been cut or drilled for test purposes, including access for test instruments, attaching jibs, and similar purposes.

1. At Tester's option, plastic plugs with retainers may be used to patch drilled holes in ductwork and housings.
PART 3 - EXECUTION

3.01 TESTING

A. Examine installed work and conditions under which testing is to be done to ensure that work has been completed, cleaned and is operable. Do not proceed with TAB work until unsatisfactory conditions have been corrected in manner acceptable to Tester. Before initiating balancing work, Contractor shall verify that systems are complete and operable. Ensure the following:

1. Equipment is operable and in a safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Duct systems are clean of debris.
6. Correct fan rotation.
7. Volume dampers are in place and open.
8. Coil fins have been cleaned and combed.
9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and connected.
11. Duct system leakage has been minimized.
12. Hydronic systems have been flushed, filled, and vented.
13. Correct pump rotation.
14. Proper strainer baskets are clean and in place.
15. Service and balance valves are open.

B. Test, adjust and balance environmental systems and components, as indicated, in accordance with procedures outlined in applicable standards.

C. Coordinate TAB procedures with any phased construction completion requirements for the project. Systems serving completed phases of the project will require TAB for such phases prior to partial final inspections.

D. Allow sufficient time in construction schedule for TAB and submission of reports prior to partial final inspections.

E. Prepare report of test results, including instrumentation calibration reports, in format recommended by applicable standards. Draft report shall be sent to Design Professional for review prior to issuance to Owner.

F. Patch holes in insulation, ductwork and housings, which have been cut or drilled for test purposes, in manner recommended by original Installer.

G. Mark equipment settings, including damper control positions, fan speed control levers, and similar controls and devices, to show final settings at completion of TAB work. Provide markings with paint or other suitable permanent identification materials.

H. Prepare a report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced; including, where necessary, modifications which exceed requirements of contract documents for HVAC work.

I. The test and balance agency shall perform the following tests and balance the air system in accordance with the following requirements (provide written substantiating data):

1. Test, adjust and record all blower RPM at design requirements.
2. Make pitot tube transverse of main supply ducts and obtain design CFM at all fans and blowers.
3. Test and record all system static pressures, suction and discharge.
4. Test and adjust all systems for design CFM of recirculated air.
5. Test and adjust all systems for design CFM of outside air.
6. Test and record entering and leaving air temperatures (DB and WB); all air units.
7. Adjust all zones to proper design CFM, supply and return.
8. Test and adjust each diffuser, grille and register within 10% design requirements.
9. In reading and tests of diffusers, grilles and registers, include design velocity and final velocity, when required, and design CFM and final CFM after adjustments.
10. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.
11. Balance fume hoods for design flow rate/face velocity, including calibration of face velocity sensors.
12. In cooperation with the control manufacturer's representative, set adjustments of all controllers to operate as specified, indicated and/or noted.
13. Flow Rate Tolerances:
   a. Applications which do not require differential pressure control: -10% to +10%.
   b. Applications which require differential pressure control:
      1) Positive zones
         a) Supply air: 0 to +10%
         b) Exhaust and return air: 0 to -10%
      2) Negative zones
         a) Supply air: 0 to -10%
         b) Exhaust and return air: 0 to +10%
   c. Minimum outside air: 0 to +10%
14. Coordinate locations of volume dampers with the mechanical contractor as required to balance the entire system.
15. Underfloor Plenum Test:
   a. This test shall be witnessed by the General Contractor and Mechanical Contractor for all underfloor plenums. The Design Professional shall also be invited to witness the test.
   b. Seal off all floor air outlets with foil tape that won't leave a residue when removed.
   c. Use a glycol solution smoke machine to charge the underfloor plenum with smoke.
   d. Once the entire plenum is charged, turn on the air handling unit that serves the underfloor plenum.
   e. Photographically document all areas where smoke leaks from the plenum, with emphasis on smoke leaking into areas that are not served by the underfloor plenum (e.g. adjacent rooms, levels below, etc.).
   f. The Contractors shall seal the areas of the plenum leaks.
   g. This process shall be repeated until the sum of all air outlets in the room meets the required flow rate tolerances.

J. The test and balance agency shall perform the following tests and balance the water system in accordance with the following requirements (provide written substantiating data):

1. Before setting pump capacities, check the following items:
   a. Automatic fill valve setting and strainer
   b. Expansion tank level
   c. Cleanliness of system water
   d. Make certain all pump strainers are clean
   e. Check air vents at coils and high points of system

2. Measure circulating pump capacities by differential pressure measurements, amperage and brake horsepower method using the pump manufacturer's capacity curve. Position all automatic valves, hand valves and balancing cocks for full flow through coils, convertors, etc. during pump adjustment. Use only calibrated test gauges for pump adjustment; the use of pressure gauges installed with the system will not be allowed.
Adjust triple duty valve as required to provide minimum differential pressure required for most remote automatic flow control valve.

3. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.

4. Balance system with automatic control valves fully open to heat transfer elements. For coils with 3-way control valves, set bypass balancing cock to provide total flow when control valve is in 100% bypass position equal to total flow when control valve is 100% open to coil.

5. Determine minimum differential pressure setpoint required to maintain flow at all water coils. Coordinate final setting with Temperature Control Contractor.

6. Coordinate the setting of controls to maintain coil water inlet design temperatures, with coil valves positioned for full flow through coil during adjustment. Balance individual water coils at full flow to maintain temperature differential specified.

7. Mark settings of all balancing cocks at required positions. Do not use service or shut-off valves for balancing unless indexed for balance point. For automatic flow control valves: Record differential pressure and verify within operating range of valve.

8. Flow Rate Tolerances:
   a. Two-pipe system pumps and coils: -10% to +10%

9. Up to 10% of automatic flow control cartridges can be replaced by the mechanical contractor if required to achieve the specified pressure or flow. Coordinate with the mechanical contractor as required.

10. Unless noted otherwise balance all domestic hot water circulation valves to 0.5 gpm.

K. Where balancer has a question regarding appropriate system configuration for balancing, balancer should contact Design Professional for clarification.

END OF SECTION 23 05 93
SECTION 23 07 00 - HVAC INSULATION

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this Section.

1.02 DESCRIPTION OF WORK

A. Provide material, equipment, labor and supervision necessary to install insulation to all hot and cold surfaces of piping, ductwork, tanks, fittings and other surfaces as required by the drawings and this section.

B. Insulation shall include insulating materials, jackets, adhesive, mastic coatings, tie wire and other materials as required to complete the insulating work.

1.03 DEFINITIONS

A. Conditioned Space: an area inside the building which is heated and/or cooled.

B. Tempered Space: an area inside the building which is not directly heated or cooled, but is adjacent to a heated or cooled space with no insulation separating the two spaces (e.g., ceiling plenums).

C. Untempered Space: an area inside the building which is not conditioned and is not tempered (e.g., attic spaces).

D. Exterior: An area outside the building (e.g., roof mounted items).

1.04 QUALITY ASSURANCE

A. NFPA Compliance: Insulating materials, jackets, mastics, etc., shall meet flame spread and smoke developed ratings in accordance with NFPA-90A. Flame spread rating of not more than 25, smoke developed rating of not more than 50 as tested by ANSI/ASTM E84 (UL 723) (NFPA 255) method. All accessory items such as PVC jacketing and fittings, adhesive, mastic, cement tape and cloth shall have the same component ratings as specified above.

B. Installation of insulation materials shall be in accordance to the latest edition of MICA/NIAC National Commercial & Industrial Standards for the appropriate material application.

C. NFPA Compliance: Fire Barrier Duct Wrap systems shall meet requirements of NFPA 96 for grease duct application.

1.05 SUBMITTALS

A. Product Data: Submit manufacturer's specifications and installation instructions for each type of HVAC insulation. Submit schedule showing manufacturer's product number, thickness, and furnished accessories for each HVAC system requiring insulation.

B. Maintenance Data: Submit maintenance data and replacement material lists for each type of HVAC insulation. Include this data in maintenance manual.
C. Certifications: Submit certifications or other data as necessary to show compliance with these specifications and governing regulations. Include proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.

1.06 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 ratings of products.

B. Protect insulation against dirt, water, and chemical and HVAC damage. Do not install damaged insulation; remove from project site.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Insulating Materials
   1. Owens/Corning Fiberglass Corp.
   2. Armacell.
   3. Pittsburgh Corning Corp.
   4. CertainTeed Corp.
   5. Knauf Fiber Glass
   7. Aeroflex

B. Fire-stop Duct Wrap Systems
   1. 3M Fire Barrier Duct Wrap 615+
   2. Thermal Ceramics Fire Master
   3. Unifrax FyreWrap

C. Mastics and adhesives as recommended by insulation manufacturer.

2.02 PIPE INSULATION

A. Type 'A': Preformed sectional heavy density fiberglass insulation and factory applied vapor barrier, all service jacket with pressure sensitive self-sealing longitudinal laps and butt strips. Suitable for operating temperatures from 0 to +850 deg. F. Thermal conductivity shall be no greater than 0.23 Btu-in/hr-sq.ft.-deg F @ 75 deg. F mean temperature. Water vapor permeance of .02 perms. Equal to Owens Corning 25 ASJ/SSL.

   1. Where insulation is exposed to weather outdoors it shall be covered with an aluminum or stainless steel weatherproof jacket 0.016" thick and sealed.
   2. Where insulation is exposed in indoor occupied space and within 8 feet of finished floor, it shall be covered with 30 mil PVC jacket equal to Johns Manville Zeston.
   3. Where insulation is exposed in a mechanical room and is within 6 feet of finished floor, it shall be covered with a 0.016" aluminum jacket.

B. Type 'B': Flexible elastomeric extruded pipe covering, 6 pound density, 0.27 K factor, water vapor permeance of 0.20 perms. Suitable for temperature from -40 deg. F to +220 deg. F. Equal to Armacell, AP Armaflex, joints sealed with adhesive as recommended by insulation manufacturer. Exposed outdoor insulation to be finished with two coats of ArmacellArmaflex WB Finish protective coating.

   1. Where insulation is exposed to weather outdoors it shall be covered with an aluminum or stainless steel weatherproof jacket 0.016" thick and sealed.
2. Where insulation is exposed in indoor occupied space and within 8 feet of finished floor, it shall be covered with 30 mil PVC jacket equal to Johns Manville Zeston.

3. Where insulation is exposed in a mechanical room and is within 6 feet of finished floor, it shall be covered with a 0.016” aluminum jacket.

C. Type ‘C’: Preformed rigid hydrous calcium silicate insulation. Mechanically fastened by wiring in place using 16 gauge wire on 9” centers and covered with suitable jacketing for indoor or outdoor application. Suitable for operating temperatures +200 to +1200 deg. F. Thermal conductivity shall be no greater than 0.42 Btu-in/hr-sq.ft.-deg F @ 200 deg. F mean temperature. Equal to Owens-Corning Kaylo asbestos-free pipe insulation.

D. Type ‘D’: Preformed rigid cellular glass insulation with factory applied self sealing jacket. Suitable for operating temperatures -200 to +900 deg. F. Thermal conductivity shall be no greater than 0.29 Btu-in/hr-sq.ft.-deg F @ 75 deg. F mean temperature. Equal to Pittsburgh Corning Foamglas with Pittwrap SS Jacketing.

E. Type ‘E’: Preformed sectional heavy density fiberglass insulation, absorbent hydrophilic wicking-cloth, and factory applied vapor barrier, all service jacket with evaporation holes aligned with inner wicking fabric and pressure sensitive self-sealing longitudinal laps and butt strips. Suitable for operating temperatures from 35 to +350 deg. F. Thermal conductivity shall be no greater than 0.23 Btu-in/hr-sq.ft.-deg F @ 75 deg. F mean temperature. Water vapor permeance of .02 perms. Equal to Knauf Fiber Glass PermaWick.

2.03 FITTING INSULATION

A. Type ‘A1’: Fittings: Insulate with mitered segments of same insulating material as for adjacent pipe covering, or with pre-molded fiberglass wired in place and covered with all-service jacket or low smoke PVC fitting covers. Valve bodies, strainer bodies, flanges, etc.: insulate with single or multiple layers of same insulating material as for adjacent pipe covering, wired in place and covered with all-service jacket.

1. Where insulation is exposed to weather outdoors it shall be covered with an aluminum or stainless steel weatherproof jacket 0.016” thick and sealed.

2. Where insulation is exposed in indoor occupied space, it shall be covered with 30 mil PVC jacket equal to Johns Manville Zeston.

3. Where insulation is exposed in a mechanical room and is within 6 feet of finished floor, it shall be covered with a 0.016” aluminum jacket.

B. Type ‘B1’: Fittings: Insulate fittings, valve bodies, strainer bodies, etc., with mitercut pipe insulation or sheet insulation of same material as pipe covering.

C. Type ‘C1’: Fittings: Insulate fittings with mitered segments of pipe insulation of same material as pipe covering, wired in place and finished with a 1/4” layer of insulating cement. Valve bodies, strainer bodies, flanges, etc.: insulate with single or multiple layers of same insulating material as pipe covering, wired in place and finished with 1/4” layer of insulating cement.

D. Type ‘D1’: Fittings: Insulate fittings with mitered segments of pipe insulation of same material as pipe covering, wired in place and covered with suitable jacketing for indoor or outdoor application. Valve bodies, strainer bodies, flanges, etc.: insulate with single or multiple layers of the same insulating material as pipe covering, wired in place, and covered with suitable jacketing for indoor or outdoor application.
E. Type ‘E1’: Fittings: Insulate with mitered segments of same insulating material as for adjacent pipe covering, or with pre-molded fiberglass wired in place and covered. Wrap all fittings with PermaWick absorbent fabric and cover with appropriate all-service jacket or Proto PermaWick PVC jackets with factory punched evaporation holes. Valve bodies, strainer bodies, flanges, etc.: insulate with single or multiple layers of same insulating material as for adjacent pipe covering, wired in place and covered with all-service jacket. Wrap all fittings with PermaWick absorbent fabric and cover with appropriate all surface jacket or Proto PermaWick PVC jackets with factory punched evaporation holes.

2.04 EQUIPMENT INSULATION

A. Type ‘G’:

1. Rigid fiberglass insulation board with factory applied all service jacket. Suitable for operating temperatures of 0 to +850 deg. F. Water vapor permeance of .02 perms. Equal to Owens Corning Series 700 with 25 ASJ facing.

2. Cut or miter insulation where necessary to fit the shape and contour of the equipment. On round surfaces band insulation in place with 3/4” x 0.015” thick galvanized steel bands 18” on center. On flat or irregular surfaces impale insulation over welded pins on 12” centers and secure with speed washers.

3. Apply vapor seal ASJ pressure-sensitive patches at damaged areas. All insulation edges and butt joints are to be sealed with pressure-sensitive joint sealing tape to match the jacket. Apply in accordance with manufacturers recommendations.

B. Type ‘H’:

1. Rigid hydrous calcium silicate insulation. Suitable for operating temperatures of +200 to +1200 deg. F. Equal to Owens-Corning Kaylo asbestos free block insulation.

2. Cut or miter insulation where necessary to fit the shape and contour of the equipment. Insulation shall be held in place with 3/4” x 0.015” thick galvanized steel bands 18” on center.

3. Insulation shall be finished with 1/2” thickness of insulating cement, in two coats.

C. Type ‘I’:

1. Flexible elastomeric insulation. Suitable for operating temperatures of -40 to +220 deg. F. Equal to Armacell Armaflex II Sheet Insulation.

2. Cut insulation where necessary to fit the shape and contour of the equipment. Insulation shall be installed using Armstrong 520 Adhesive.

3. Exposed outdoor insulation shall be finished with two coats of Armacell Armaflex finish.

2.05 DUCT INSULATION

A. Duct Covering: Johns Manville Microlite Standard or equivalent fiberglass duct wrap with factory applied Foil Scrim Kraft (FSK) vapor barrier jacket, 0.6 pound per cubic foot density.

B. Rigid Duct Covering: Johns Manville or equivalent semi-rigid fiberglass insulation board with a factory applied Foil Scrim Kraft (FSK) vapor barrier jacket, three (3) pound per cubic foot density. Exterior rigid duct insulation to be covered with VentureClad 1577CW multilayered, self-adhesive jacketing system.
C. Fire-stop Duct Wrap System shall be of materials as follows:

1. Type F1 Duct Covering: FyreWrap Elite 1.5 Duct Insulation, 6 pounds per cubic foot density, high temperature fiber thermal insulation, encapsulated with an aluminum foil, fiberglass reinforced scrim covering. Meeting requirements of ISO 6944 for one- and two-hour rated air ventilation duct enclosures, ASTM E119, ASTM E814, ASTM E84, ASTM E136, and ASTM C518.

2. Type F2 Duct Covering: FyreWrap Elite 1.5 Duct Insulation, double-layer of 1.5” thick encapsulated wrap with aluminum foil fiberglass reinforced scrim covering. Meeting requirements of ASTM E-2336 for one- and two-hour rated commercial kitchen grease duct enclosure assemblies, ASTM E119, ASTM E814, ASTM E84, ASTM E136, and ASTM C518.

PART 3 - EXECUTION

3.01 GENERAL

A. Use only experienced applicators regularly engaged in the trade. Rough work will be rejected. Application details shall be in accordance with the insulating materials supplier's recommendations except where a higher standard is specified. All surface finishes shall be extended in such a manner as to protect all raw edges, cuts and surfaces of insulation.

B. All piping shall be insulated unless specifically noted otherwise. Piping not noted in the table below shall be insulated with thicknesses matching ASHRAE 90.1 based on the fluid temperatures.

*******NOTE: Not all services apply – refer to plans for scope of services. **********

3.02 PIPE INSULATION APPLICATION

<table>
<thead>
<tr>
<th>Service</th>
<th>Type Insulation and Thickness *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above Ground Piping</td>
<td></td>
</tr>
<tr>
<td>Hot water heating lines, supply and return, condenser water for building heating</td>
<td>Type A and A1: 1-1/4” and smaller - 1-1/2” thick 1-1/2” and larger - 2” thick</td>
</tr>
<tr>
<td>Type C and C1: 1-1/4” and smaller – 2-1/2” thick 1-1/2” to 6” – 3” thick 8” and larger – 4” thick</td>
<td></td>
</tr>
<tr>
<td>Chilled water, heat pump water lines, evaporator water, ground water, well water, system make-up water</td>
<td>Type A and A1: 6” and smaller – 1” thick 8” and larger – 1-1/2” thick</td>
</tr>
<tr>
<td>Type B and B1: 6” and smaller – 1” thick 8” and larger – 1-1/2” thick</td>
<td></td>
</tr>
<tr>
<td>Type E and E1: 6” and smaller – 1” thick 8” and larger – 1-1/2” thick</td>
<td></td>
</tr>
</tbody>
</table>
Condensing appliance flue pipe
in un-heated spaces

Type A and A1:
All pipe sizes – 1-1/2” thick

Type B and B1:
All pipe sizes – 1” thick

Condensate drain lines
Type A and A1: 1” thick for all pipe sizes.

Heat exchangers
condensate receivers,
air separators
Type G: 2” thick.
Type H: 3-1/2” thick

Refrigeration piping (except liquid lines)
Type B and B1:
3/4” and smaller – 3/4” thick
1” to 2” – 1” thick
2-1/2” and larger – 1-1/2” thick

* For piping exposed to outdoor ambient temperatures, increase thickness by 1/2”

3.03 PIPE INSULATION INSTALLATION

A. Do not insulate the following:
   1. Valve bonnets
   2. Unions in hot piping
   3. TC valve operators
   4. Hot piping within radiation enclosures or unit cabinet.
   5. Cold piping within unit cabinets provided piping is located over drain pan.
   6. Condensate piping between steam trap and union.
   7. Preinsulated expansion joints

B. Inspect all piping and equipment before applying insulation to insure the installing contractor has completed all leak tests, and that all surfaces are clean, dry and ready for application of insulation.

C. Covering for "cold" pipes shall pass unbroken through hanger clevises, sleeves, etc. All details of covering for cold surfaces shall be such that continuous covering with unbroken vapor barrier and uncompressed insulation is provided as required to prevent condensation. The same covering and hanging detail shall be used for pipes connecting to vibrating equipment or carrying pulsating pressures to avoid metal contact between pipes and hangers.

D. Insulation at removable heads, manhole covers, strainer plugs, and other access points shall be fabricated in such a manner that it can be readily removed without damage to the insulation. Removable insulation shall have a vapor proof cover fabricated so as to allow it to be resealed to the equipment vapor barrier.

E. Provide rigid insulation inserts at hangers for pipes sizes 2” and larger. Inserts shall be polyisocyanurate or calcium silicate, a minimum of 180 degrees and extend 2” beyond the hanger shield. Refer to MICA Plate 1-610. Wood or plastic block hanger inserts shall not be used.

F. Use hydraulic insulating cement anywhere insulation fibers are exposed, to fill voids, and to repair damages to the factory applied vapor barrier. Finish with material matching or compatible with adjacent jacket material.
3.04 DUCT INSULATION APPLICATION
A. Unless noted otherwise, all ductwork and accessories shall be either lined or covered as scheduled on plans. If type or thickness is not indicated, it shall be insulated with thicknesses matching ASHRAE 90.1 based on the fluid temperatures.

3.05 DUCT COVERING INSTALLATION
A. Inspect all ductwork and equipment before applying insulation to insure the installing contractor has completed all leak tests, and that all surfaces are clean, dry and ready for application of insulation.
B. Covering shall be cut slightly longer than circumference of duct to insure full thickness at corners. All insulation shall be adhered with edges tightly banded, and shall be adhered to duct with fire resistant adhesive. Adhesive shall be applied so that insulation conforms to duct surfaces uniformly and firmly.
C. In addition to the adhesive, the insulation shall be additionally secured to the bottom of all ducts 18" or wider by means of grip nails and speed clips. The protruding ends of the pins shall be cut off flush after the speed clips have been applied. The vapor barrier facing shall be thoroughly sealed with a vapor barrier mastic and tape where the pins have pierced through.
D. Insulation for "cold" ducts and accessories shall pass unbroken through hangers, sleeves, fire dampers, flexible connectors, reheat coils, etc. as required to prevent condensation. All details of covering for cold surfaces shall be such that continuous covering with unbroken vapor barrier and uncompressed insulation is provided. The same covering and hanging detail shall be used for ducts connecting to vibrating equipment or carrying pulsating pressures to avoid metal contact between ducts and hangers. Insulation Contractor shall be responsible for coordination with equipment suppliers as required to ensure continuous covering of unlined equipment components, i.e. VAV terminal unit supply collar and exposed reheat coil u-bends, fan coil unit discharge, etc.
E. Insulation at all access points shall be fabricated in such a manner that it can be readily removed without damage to the insulation. Removable insulation shall have a vapor proof cover fabricated so as to allow it to be resealed to the equipment vapor barrier.

3.06 FIRE-BARRIER DUCT WRAP INSTALLATION
A. Install duct wrap TYPE F2 fire-stop system as required to comply with ASTM E2336, NFPA 96 requirements for grease duct application, duct wrap system manufacturer’s written installation instructions and published drawings for products and applications indicated.
B. Install duct wrap TYPE F1 fire-stop system as required to comply with ISO 6944, ASTM E119, ASTM E814, and all local and state codes to extend the fire-rated shafts or enclosures of supply, return, exhaust and outdoor air ductwork.
C. Type F1: Install duct wrap fire-stop system in direct contact with the duct that it encloses. Protect every portion of duct with no less than 1 layer as required for duct applications. Overlap both perimeter and longitudinal joints with a minimum of 3” per layer of material.
D. Type F2: Install duct wrap fire-stop system in direct contact with the duct that it encloses. Protect every portion of duct with no less than 2 layers as required for grease duct applications. Overlap both perimeter and longitudinal joints with a minimum of 3” per layer of material.
E. Type F2: Locate grease duct access doors at horizontal cleanouts as required by local codes. Protect with 3 layers of duct wrap fire-stop system material, each layer overlapping previous 1” on all sides and in accordance with manufacturer's instructions. All edges shall be covered with aluminum tape. All layers shall fit tight and overlap previous layer as required by installation instructions. Duct wrap shall be locked in place by galvanized speed clips. Alternatively, provide a UL 1978 and ASTM E2336 listed enclosure and door system. Install in strict accordance to manufacturer's installation instructions.

F. Repair Procedure.

1. Repair damaged duct wrap fire-stop system material in accordance with manufacturer's instructions.

2. Remove damaged section. Apply a new section of the same dimension. Place and fit ensuring same overlap that existed previously. Place banding around new duct wrap fire-stop system material and tension to sufficiently hold in place. If damage has penetrated to interior layer, remove affected sections and reinstall as specified in 3.03 A.

END OF SECTION 23 07 00
PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements Division 22 – Plumbing, Division 23 – HVAC, Division 26 – Electrical, Division 27 – Telecommunications, and Division 28 – Electronic Safety and Security are applicable to work required of this section.

B. Coordination:

1. Coordination Required by BAS Contractor: The BAS Contractor shall provide all required information, material, direction and installation instructions to the designated contractor as required to allow this work to be completed in a timely/cost effective manner. This includes, but is not limited to, the following:

a. Coordinate with General Contractor prior to the start of construction:
   i. Locations of all sensors and devices located in CMU walls, concrete walls, concrete slabs, pre-cast walls, etc. Where shop drawing(s) are provided for these items, the locations shall be shown on the submitted shop drawing(s).

b. Coordinate with the HVAC and Plumbing Piping Contractor prior to the installation of piping on site:
   i. Locations of and pipe size transitions for all sensors, control valves, etc., ensuring accurate readings/operation and required access.
   ii. Locations of water flow measuring stations (WFMS) meeting the installation requirements for straight lengths of pipe upstream and downstream of the WFMS for the specific piping arrangement.

c. Coordinate with Sheet Metal Contractor prior to the submittal of ductwork shop drawings:
   i. Locations of all sensors, dampers, etc., ensuring accurate readings/operation and required access.
   ii. Locations of airflow measuring stations (AFMS) meeting the installation requirements for straight lengths of duct upstream and downstream of the AFMS for the specific ductwork arrangement.

d. Coordinate with Testing and Balancing Contractor:
   i. Provide support and coordination with Testing and Balancing (TAB) Contractor for all interfaces between controls and TAB scope of work. Provide all devices and timely access to the BAS for TAB Contractor use in completing TAB procedures.

e. Coordinate with Electrical Contractor:
   i. Quantities and locations for line voltage power requirements for powering BAS panels and devices.
   ii. If additional line voltage power is required for the operation of the BAS beyond the scope shown on the plans, it is the BAS Contractor's responsibility to provide the additional power; however, this work shall be performed by a qualified Electrical Contractor in accordance with the requirements of Division 26 specifications and included in the BAS Contractor's bid.
   iii. Quantities and locations of additional junction boxes required for controls components installed in electrical wiring systems (e.g. current sensor, relays, etc.).
f. Coordinate with Telecom Contractor:
   i. Quantities and locations of information outlet(s).
   ii. If additional information outlets are needed beyond the quantity shown on the plans, it is the BAS Contractor's responsibility to provide these additional outlets. This work shall be performed by a qualified Telecom Contractor in accordance with Division 27 specifications and included in the BAS Contractors bid.

g. Coordinate with Fire Alarm Contractor:
   i. Quantities and locations for all points of connection between the BAS and fire alarm system.

2. Work by Others: The following incidental work shall be furnished by the designated under the supervision of the BAS Contractor.

h. HVAC and Plumbing Piping Contractor shall:
   i. Install automatic valves, wells, flow switches, and water flow measuring stations that are specified to be supplied by the BAS Contractor.
   ii. Install all pipe mounted BAS items including wells, paddle switches and differential pressure switches, including their isolation valves and associated tubing.

i. Sheet Metal Contractor shall:
   i. Install all automatic dampers furnished by the BAS Contractor. Assemble multiple section dampers with required interconnecting linkages and extend required number of shafts through duct for external mounting of damper actuators.
   ii. Provide necessary blank-off plates or ductwork transitions required to install dampers that are smaller than the duct size.
   iii. Provide access door or other approved means of access through ducts for service to control equipment.

1.02 DESCRIPTION OF WORK

A. Contractor shall furnish and install a complete fully functioning BAS including all necessary hardware and all operating and applications software necessary to perform the control sequences of operation as called for in this specification and on the plans. The BAS Contractor shall include all items not specifically itemized in these specifications that are necessary to implement, maintain, and operate the system in compliance with the functional intent of these specifications. The BAS shall be a complete system designed for use on Intranets and the Internet. Contractor shall be responsible for coordination with the Owner without disruption to any of the other activities taking place on that LAN.

B. The BAS shall possess a fully modular architecture, permitting expansion in the future through additional controllers, sensors, actuators, etc.

C. Manage and coordinate the BAS system work in a timely manner in consideration of the project schedule. Coordinate cooperatively with the associated work of other trades so as to assist the progress and not impede or delay the work of associated trades.

1.03 QUALIFICATIONS

A. The control system shall be installed by competent control mechanics and electricians employed by the BAS Contractor. BAS Contractor is responsible for all work performed by their subcontractors.
B. All bidders must be BAS Contractors in the business of installing direct digital control building automation systems for a minimum of 3 years. BAS Contractors must also have a minimum of five completed projects of similar size and complexity that have been in operation at least one year with the product line that will be used on this project. Any request for substitution must include a list of projects and completion dates to demonstrate compliance with this requirement.

C. The BAS system shall be provided by a single source manufacturer offering a full line of controllers. This system shall be furnished, engineered, and installed by the manufacturer's local branch office or the manufacturer's locally authorized representative. BAS Contractor shall have factory trained technicians to provide instruction, routine maintenance, and emergency service within 24 hours upon receipt of request.

D. Control system components shall be the manufacturer's latest standard of design at the time of bid and in conformance with the following applicable standards for products specified.

1.04 QUALITY ASSURANCE

A. The building automation system and components shall meet the following regulatory requirements:

1. American Society for Testing and Materials, ASTM.
2. Institute of Electrical and Electronic Engineers, IEEE.
3. National Electrical Manufacturers Association, NEMA.
4. Electronics Industries Alliance, EIA.
5. National Fire Protection Association, NFPA.
6. National Electrical Code, NEC.
11. Local building codes.

1.05 SUBMITTALS

A. The following shall be submitted for approval prior to commencing construction of the BAS:

1. Contractor Qualifications: Document compliance with qualification requirements listed above. Include names, email addresses, and phone numbers of the project manager, primary programmer, electrical sub-contractor, and other team members.
2. BAS Design Submittal, including:
   a. A bookmarked PDF with bookmarks for each plan sheet with title and number, each schedule, and each product cut sheet with appropriate description.
   b. A table of contents listing sheet titles and sheet numbers.
   c. A floor plan showing the proposed locations of all network controllers.
   d. BAS network architecture diagrams including all controllers, repeaters, gateways, interconnections, etc.
   e. Calculations showing that system architecture can support the minimum trending and data storage requirements of the project with a written guarantee that the final installation will meet the project trending and storage requirements.
   f. Schematics with accurate arrangement of devices as they relate to the equipment.
   g. Sequences and points lists as intended to be installed and programmed. A direct copy of the sequences and points lists from the plans will not be acceptable.
   h. Points schedule for each physical point shown on the schematics, including: tag, point type, system name and display units.
i. Point-to-point wiring diagrams including start-stop arrangement for each piece of equipment, equipment interlocks, controller wiring terminal numbers and any special connection information required for properly controlling the HVAC equipment.

j. Controller schedule, including quantity, part number, description, and optional features.

k. Control damper schedule including a separate line for each damper and a column for each of the damper attributes, including: associated system, associated equipment, part number, fail position, damper type, damper operator, blade type, bearing type, seals, duct size, damper size, damper material, mounting, and actuator type.

l. Control valve schedules including a separate line for each valve and a column for each of the valve attributes: associated system, associated equipment, part number, configuration, fail position, pipe size, valve size, valve type, valve material, close off pressure, capacity, valve CV, calculated CV, design pressure, actual pressure, and actuator type.

m. Airflow measuring station schedules including a separate line for each AFMS and a column for each of the AFMS attributes: associated system, associated equipment, part number, type, duct/fan inlet size, AFMS material, velocity range, and design airflow.

n. Product cut sheets including manufacturer’s catalog data describing each item of control equipment or component provided and installed for the project. Cut sheets shall include performance data as applicable (e.g. valve CV, damper pressure drops, operating range, sensor accuracy, sensor units, sensor, sensor hysteresis, sensor stability, etc.).

o. Product cut sheets for the operator workstation and any data storage devices including all technical specifications.

B. The following shall be submitted for approval a minimum of two months prior to substantial completion:

1. Floor plan graphics.
2. One sample graphic of each different equipment arrangement included on the project. Graphics that are not identical (except for equipment labels) need to be submitted as separate graphics.

1.06 SOFTWARE LICENSES

A. Provide required copies of all licenses for software, including software licenses on local workstations and software loaded or embedded into controllers or other network devices. BAS licensing shall allow for unlimited access to the system; no restrictions shall be placed on the licensing. All software used by the Contractor to install the system or needed to operate the system to its full capabilities shall be licensed and provided to the Owner.

1.07 CLOSEOUT REQUIREMENTS

A. Within one month prior to project substantial completion, calibrate all CO₂ and specialty gas sensors and generate calibration reports. Turn over all calibration kits to the Owner.

B. Provide instructions on how to calibrate all sensors on the project. If a sensor cannot be field recalibrated but has the ability for replacement calibrated parts, include a source for obtaining the replacement parts.
C. Refer to 23 00 10 for Operation and Maintenance (O&M) and Owner training requirements. All products and devices installed shall be included in the O&M manual. Include the following:

1. Manufacturer's catalog data and specifications on sensors, transmitters, controllers, control valves, damper actuators, gauges, indicators, terminals, and any miscellaneous components used in the system.
2. A copy of all device calibration reports and certifications (e.g. NIST).
3. An operator's manual which will include detailed instructions for all operations of the system.
4. Operating and maintenance cautions and instructions.
5. An operator's reference table listing the addresses of all connected input points and output points. Settings shall be shown where applicable.
6. A programmer's manual which will include all information necessary to perform programming functions.
7. A language manual which will include a detailed description of the language used and all routines used by the system.
8. Flow charts of the overall system configuration.
9. Complete program listing file and parameter listing file for all programs.
10. A copy of all software licenses.
11. A copy of the warranty.
12. Recommended spare parts list.

D. Provide as-built documentation in the same format as the BAS Design Submittal, updated with all revisions and as-built conditions. Place a digital copy with a link from the BAS to the final as-built documentation. Also include a PDF copy on the operator workstation, if provided. As-builts shall be submitted after the system demonstration has been performed. Include a copy of the as-built point-to-point wiring diagrams and final programmed sequence inside each control panel enclosure. Also indicate exact installed locations on the floor plans for the following:

1. All network controllers
2. Pump differential pressure sensors
3. Fan differential pressor sensors
4. Outdoor air temperature and/or humidity sensor

E. Provide a warranty on the entire system, including software, hardware, and labor. Refer to 23 0010 for warranty requirements. Provide an extended five (5) year warranty on all control valves and control valve actuators.

1. In the last month of the warranty period, all BAS software and controller firmware, software, drivers, etc., shall be upgraded and validated to the latest release (version) in effect at the end of the warranty period.
2. At the end of the warranty period, the final version of all BAS software and programming shall be fully backed up on external storage device(s) (e.g. CD, USB drive, etc.). Include all software licenses. Turn the external storage device over to the Owner.

1.08 PRE-PROGRAMMING DESIGN REVIEW MEETING

A. Prior to starting programming, a design review meeting shall be scheduled with the Design Professional. The agenda of this meeting will be to discuss the design intent, review all systems requiring control, review naming conventions, and answer any questions the Temperature Controls Contractor may have.
1.09 DESIGN PROFESSIONAL BAS ACCESS

A. The BAS Contractor shall provide BAS access to the Design Professional prior to substantial completion or the date of the final punch list, whichever occurs first. This shall include a username and password unique to the Design Professional.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, acceptable manufacturers are as follows:

1. Johnson Controls – Johnson Controls, Inc., Cedar Rapids Branch Office
2. Siemens – Modern Control Services

2.02 SYSTEM ARCHITECTURE

A. The complete electronic BAS system may be comprised of the following levels of control devices.

1. Operator Workstation includes the hardware and software necessary for an operator to interface with the control system.
2. Central File Server shall store all data required by the system and be permanently connected to the network.
3. Network Controller(s) are used for high level global programming functions and system networking.
4. Local Controllers are for control of large primary HVAC systems such as air handling systems, heating hot water systems and chilled water systems.
5. Application Specific Controllers are dedicated for specific equipment such as VAV boxes, fan coils, and heat pumps.
6. Repeaters are used for communication signal enhancement along the Tier 2 network.
7. Gateways are used to allow communication between two different communication protocols.
8. Network thermostats dedicated to specific equipment such as VAV boxes, fan coils, or heat pumps, etc.
9. Field devices include, but are not limited to, electronic sensors, valves, actuators, switches, relays, and transducers.
10. Tier 1 level network is the main backbone of the system and shall be an Ethernet Local Area Network (LAN). All network controllers, the Operator Workstation, and the Central File Server shall be connected directly to this network without the need for gateway devices.
11. Tier 2 level networks are the communication busses managed by the network controllers. Local Controllers and Application Specific Controllers shall reside on a Tier 2 communication bus without any third-party controllers. All third-party controllers shall reside on a Tier 2 communication bus dedicated to third-party controllers.

B. Data throughout any level of the network shall be available to and accessible by all other devices, controllers, the Central File Server, and the Operator Workstation.

C. Interruptions or faults at any point on the network shall not interrupt communications between other nodes on the network.

D. The BAS network shall support both copper and optical fiber communication media.

E. All line drivers, repeaters, signal conditioners, etc., shall be provided as necessary for proper data communication.
F. The system shall use the same application programming language for all levels.

G. The system shall be configured as a distributed processing network(s) capable and shall be scalable and expandable at all levels of the system using the same software interface and the same types of controllers. Systems that require replacement of either the workstation software or any controllers to expand the system shall not be acceptable.

2.03 OPERATOR WORKSTATION

A. Provide a desktop computer operator workstation with the following minimum requirements:
   1. Processor with a minimum 64-bit structure and minimum 2 GHz processor speed.
   2. Onboard RAM of 4 GB.
   3. Hard drive or equal high-speed data storage with a minimum of 500 GB or as required to meet minimum data storage requirements of the project.
   5. Removable high-speed data storage and export device(s) such as USB (minimum of 2 ports).
   6. Ethernet port.
   7. Full color, flat screen monitor, minimum 24 inches diagonal screen, 16:9 aspect ratio, minimum 1920 x 1080 resolution.
   8. Full ASCII keyboard with wired connection.
   10. Software and licenses as required to allow for full functionality of the BAS system.
   11. Server software or capability as required by project trending and storage requirements.

2.04 DATA STORAGE

A. Central File Server:
   1. College Community School District Central Server

2.05 OPERATOR INTERFACE

A. General: The BAS operator interface shall be user friendly, readily understood and shall make maximum use of colors, graphics, icons, embedded images, animation, text based information and data visualization techniques to enhance and simplify the use and understanding of the BAS system by authorized users at the Operator Interface.

   1. User access to the BAS system shall be protected by a flexible and Owner redefinable software-based password access protection. Password protection shall be multi-level (minimum of 4 levels) and partitionable to accommodate the varied access requirements of different user groups. Provide the means to define unique access privileges for each individual authorized user. Also provide the means to establish general password groups to which an individual will then be assigned. Once assigned to the group each individual will assume all the capabilities and restrictions of that group. Provide the means to manage individual user password and access privileges under the control of a master password.

   2. The operator interface shall be able to combine data from any and all of the system components in a single browser window. This shall include historical data stored on a server.

   3. The operator interface shall incorporate comprehensive support for functions including, but not necessarily limited to, the following:
      a. User access for selective information retrieval and control command execution.
      b. Monitoring and reporting.
      c. Alarm, non-normal, and return to normal condition annunciation.
d. Selective operator override and other control actions.
e. Information archiving, manipulation, formatting, display and reporting.
f. BAS internal performance supervision and diagnostics.
g. On-line access to user HELP menus.
h. On-line access to current BAS as-built records and documentation.
i. Means for the controlled re-programming, re-configuration of BAS operation and for the manipulation of BAS database information in compliance with the prevailing codes, approvals and regulations for individual BAS applications.

4. Provide BAS reports and displays making maximized use of simple English language descriptions and readily understood acronyms, abbreviations and the like to assist user understanding and interpretation.

5. All text naming conventions shall be consistent in their use and application throughout the BAS and coordinated with Owner preference.

B. Web Interface

1. The system shall be capable of supporting clients using a standard web browser such as Internet Explorer™. Systems requiring additional software (to enable a standard Web browser) are not acceptable.

2. The web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the graphical user interface on the operator workstation. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be acceptable.

3. The web browser client shall support at a minimum, the following functions:
   a. User log-on identification and password shall be required. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
   b. Users shall have administrator-defined access privileges.
   c. The system shall provide the capability to specify a users home page. Provide the ability to limit a specific user to just their defined home page. From the home page links to other views, or pages in the system, shall be possible if allowed by the system administrator.
   d. Graphical screens developed for the operator interface shall be the same screens used for the web browser client. Any animated graphical objects supported by the operator workstation software shall be supported by the web browser interface.
   e. HTML programming shall not be required to display system graphics or data on a web page. HTML editing of the web page shall be allowed if the user desires a specific look or format.
   f. Real-time values displayed on a web page shall update automatically without requiring a manual “refresh” of the web page.
   g. Graphic screens on the web browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

C. Alarms: Alarms shall be routed directly from network controllers to the operator workstation and/or servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers. The alarm management portion of the operator interface software shall, at the minimum, provide the following functions:

1. The BAS shall annunciate diagnostic alarms, at a minimum, indicating system failure, individual controller failure, individual component failure, and non-normal operating conditions.
2. Any attribute of any object in the system may be designated to report an alarm.
3. Log date and time of alarm occurrence.
4. Generate a “pop-up” window, with audible alarm, informing a user that an alarm has been received.
5. Allow a user, with the appropriate security level, to acknowledge, temporarily silence, or discard an alarm.
6. Provide an audit trail on hard drive for alarms by recording user acknowledgment, deletion, or disabling of an alarm. The audit trail shall include the name of the user, the alarm, the action taken on the alarm, and a time/date stamp.
7. Provide the ability to direct alarms to an e-mail address or phone number via text message. This must be provided in addition to the pop up window described above. Systems which use e-mail and/or text messaging as the exclusive means of annunciating alarms are not acceptable.

D. Reports: Reports shall be generated and directed to one or more of the following: operator interface displays or an archive at the user’s option. As a minimum, the system shall provide the following reports:

1. All points in the BAS system.
2. All points in each BAS application.
3. All points locked out or overridden in a BAS application.
4. All points currently in alarm in a BAS application.
5. All BAS schedules.
6. All user defined and adjustable variables, schedules, interlocks, etc.
7. BAS diagnostic and system status reports.

E. Navigation Tree: The system shall have an intuitive and easy to navigate collapsible and expandable navigation tree. Requirements of the navigation tree shall include:

1. A dedicated folder where links to all graphics are located. In systems with many different graphics, locate similar equipment graphics in a sub-folder (e.g. VAVs for Level 1 in a sub-folder).
2. A grouping of all systems/equipment/points by the network controller and communication bus it resides on. All systems and equipment shall match the names indicated on the plans.
3. A minimum of 5 collapsible and expandable levels.
4. Links to long-term trends.
5. Links to all alarms and alarm history logs.
6. Ability for the operator to customize the navigation tree by defining groupings and adding any systems or points to those groups and modifying the order of groups.
7. Ability for groups to be located within other groups.
8. Ability to rename any group, system, or point in the navigation tree.

F. Dynamic Color Graphics: The system shall allow for the creation of user defined, color graphic displays for the viewing of HVAC, systems, electrical systems, building schematics, etc. These graphics shall contain point information from the database including any attributes associated with the point (engineering units, etc.). In addition, users with the appropriate security level shall be able to command equipment or change setpoints from a graphic through the use of the mouse. Requirements of the color graphic subsystem include:

1. An unlimited number of graphic displays shall be able to be generated and executed.
2. Graphics shall be based on vectorized technology and HTML5 programming language. Rasterized graphics and Java programming language are not acceptable.
3. Values of real time attributes displayed on the graphics shall be dynamic and updated on the displays.
4. The graphic displays shall be able to display and provide animation based on real-time BAS data that is acquired, derived, or entered.
5. Users with the appropriate security level shall be able to change values (setpoints) and states in system controlled equipment directly from the graphic display.
6. Provide a graphic editing tool that allows users with the appropriate security level to create and edit graphic files. It shall be possible to edit the graphics directly while they are on line, or at an off line location for later downloading to the controller.

7. BAS system shall be provided with a complete user expandable symbol library containing all of the basic symbols used to represent typical system components. Implementing these symbols in a graphic shall involve dragging and dropping them from the library to the graphic.

8. The following graphics, at a minimum, shall be provided:
   a. Floor plan graphics showing all as constructed room numbers, zoning boundaries, zone level space sensors readings (temperature, relative humidity, occupancy, CO₂, CO, etc.) and indicate accurate locations of the sensors. The floor plan graphics shall also show the as constructed location and name of all network controllers.
      i. All readings shall be color coded to indicate the deviation from current set point and a legend describing the colors and associated deviation scale.
      ii. Any readings in an alarm shall flash on the graphic.
      iii. All zones shall include a link to the zone level equipment graphic page.
   b. Central system graphics showing all equipment and components with interconnecting piping/ductwork in schematic form. Equipment and components shall be accurately placed relative to each other on the schematic.
      i. Each hydronic piping system.
      ii. Overall building pressure with all airflows entering and leaving the building.
   c. A graphic screen for all equipment connected to the BAS system. At a minimum, all points listed in the minimum points list on the plans shall be visible on the graphic screen.
      i. Include a separate graphic screen for every individual piece of equipment. Where two or more pieces of equipment are redundant (e.g. system pumps), they may reside on the same graphic screen.
      ii. Where a reset or staging schedule is required, include the details of the reset schedule and staging schedule on the graphics. Indicate the current set point or stage as calculated by the reset or staging schedule.
      iii. Where a software button is required by the sequence, include the software button on the graphic.
      iv. All software points listed on the plans shall also be included on the graphic.
   d. Where redundant equipment is set up as lead/lag, the graphic screen shall include the ability for the user to switch the lead/lag positions.

G. Schedules: It shall be possible to configure and download all schedules within the BAS from the operator interface.

1. The system shall provide multiple schedule input forms for automatic BAS time-of-day scheduling and override scheduling of BAS operations. At a minimum, the following spreadsheet types shall be accommodated:
   a. Weekly schedules.
   b. Monthly schedules.
   c. Special “Only active if today is a holiday” schedules.
   d. Temporary override schedules.

2. Schedules shall be provided for each individual piece of equipment. Similar equipment on the same system shall also be able to be scheduled globally. For example, All VAVs on an AHU system shall be able to have the same schedule as the AHU or their own individual schedule for each VAV. Each schedule shall include all output points residing within the system. Each point may have a unique schedule of operation relative to the system use schedule, allowing for sequential starting and control of equipment within the system. Scheduling and rescheduling of points shall be accomplished easily via the system schedule spreadsheets.
3. Monthly calendars for a 12-month period shall be provided that allow for simplified scheduling of holidays and special days in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the weekly schedules.

H. Power failure and automatic restart:
1. Provide for the automatic, orderly and predefined shutdown of parts or all of the BAS following total loss of power to parts or all of the BAS.
2. Provide for the automatic, orderly and predefined startup and return to normal control of parts or all of the BAS following total loss of power to those parts or all of the BAS. Archive and annunciate time and details of restoration.
3. Maintain the operation of the BAS real-time clock during periods of power outage for a minimum of 72 hours.

I. Historical trending and data collection: Trend and store point data as indicated on the plans. Long-term data collection can be stored locally if memory allows or offloaded to a separate system server or hard drive. Data shall be capable of being exported in a .csv, .xls or .xlsx format or other acceptable formats for custom queries and reports using industry standard software analysis tools.

1. Trend shall be capable of recording as raw data or data that is filtered where specified to be filtered before recording by the following typical filter types:
   a. Average value.
   b. Maximum value.
   c. Minimum value.
   d. Change of value (COV).
   e. Change of state (COS).
   f. Range – difference between minimum and maximum values.

2. The software shall be able to perform the following functions on a set of user selected data:
   a. Standard deviation.
   b. Sum of all values.
   c. Variance.

3. Trends shall be able to be displayed in a table or graphical format. Trends shall be able to be saved in the navigation tree for future reference. The graphical display shall have the following capabilities:
   a. Displaying multiple trends of any user selected points on one graph.
   b. Adjust both the x-axis and y-axis scales.
   c. Utilize multiple y-axes with unique scales and assign trends to either axis at the user’s choosing.
   d. Change trend colors, line types, and line weights.
   e. Change display of trends between analog values and binary. Binary displays shall have the option to be displayed as a square wave.

J. Point naming conventions and abbreviations shall be consistent with the plans and be consistent between all systems and equipment.

2.06 NETWORK CONTROLLERS

A. General: The network controller shall be a microprocessor based, multi-tasking real time system controller that provides advanced system programming, uplink and downlink communications, polling and other supervisory functions for local and application specific controllers.

B. Each network controller shall be classified as a BACnet compatible device, supporting the BACnet Building Controller (B-BC) profile. Controllers that support a lesser profile such as B-AAC, B-ASC, or B-SA are not acceptable. Network controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as Advanced Application Controllers (B-BC).
C. Hardware Specifications

1. Operating Environment: The controller shall be capable of operating in an environment of 32 to 122 deg F and 10 to 90% relative humidity non-condensing.

2. Memory: Both the operating system of the controller, plus the application program for the controller, shall be stored in non-volatile, FLASH memory. Controllers shall contain enough memory for the current application, plus required history logging, plus a minimum of 20% additional free memory. If the controller does not have the required built-in memory capacity, a separate data storage device shall be provided.

3. Communication Ports: Each network controller shall provide communication to both the Operator Workstation(s) and the field buses. An on-board Ethernet port shall be provided.

4. Stand-Alone: The controller shall be a true no-host system that does not require a PC or "Host" computer to perform any control functions or communications.

5. Modular Expandability: The system shall employ a modular input/output (I/O) design to allow easy expansion. Input and output capacity is to be provided through plug-in modules. It shall be possible to combine I/O modules as desired to meet the I/O requirements for individual control applications.

6. Real Time Clock (RTC): Each network controller shall include a battery-backed, real time clock, accurate to 10 seconds per day. The RTC shall provide the following: time of day, day of week, day, month, and year. The system shall automatically correct for daylight savings time and leap years.

7. Power Supply: The power supply for the network controller shall be auto sensing, 120 VAC, 60 Hz power, with a tolerance of +/- 20%. Line voltage below the operating range of the system shall be considered a power outage. The controller shall contain over voltage surge protection and require no external AC power signal conditioning.
   a. Automatic Restart After Power Failure: Upon restoration of power after an outage, the network controller shall automatically and without human intervention: update all monitored functions, resume operation based on current, synchronized time and status, and implement special start-up strategies as required.
   b. Battery backup: The network controller shall include an on-board battery to back up the controller’s RAM. The battery shall have a shelf life of over 5 years and provide accumulated backup of all RAM and clock functions for at least 30 days. In the case of a power failure, the network controller shall first try to restart from the RAM memory. If that memory is corrupted or unusable, then the network controller shall restart itself from its application program stored in its FLASH memory.

8. Field communication ports shall be individually electrically isolated to protect against transients, spikes, and power surges. The ports shall be optically isolated from each other, the controller circuit board and from power wiring. Optical isolation shall be provided either as an integral component to the controller or provided as a separate interface device between the controller and field wiring.

9. Failure of any network controller shall register as an alarm in the BAS.

D. Network Controller Software

1. General: The network controller shall contain FLASH memory to store both the resident operating system and the application software. There will be no restrictions placed on the type of application programs in the system. Each network controller shall be capable of parallel processing and executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.
2. Passwords: User access to the controller shall be protected by a flexible and Owner redefinable software-based password access protection. Password protection shall be multi-level (minimum of 4 levels) and partitionable to accommodate the varied access requirements of different user groups. Provide the means to define unique access privileges for each individual authorized user. Also provide the means to establish general password groups to which an individual will then be assigned. Once assigned to the group each individual will assume all the capabilities and restrictions of that group. Provide the means to manage individual user password and access privileges under the control of a master password.

3. Login: A user definable login message shall be displayed every time the workstation is connected to a system controller.

4. User Programming Language: The application software shall be user programmable. This includes all strategies, sequences of operation, control algorithms, parameters, and setpoints. The source program shall be English language-based and programmable by the user. The language shall be structured to allow for the easy configuration of control programs, schedules, alarms, reports, telecommunications, local displays, mathematical calculations, passwords, and histories. The language shall be self-documenting. Users shall be able to place comments anywhere in the body of a program. Program listings shall be configurable by the user in logical groupings. Controllers that use a "canned" program method will not be accepted.

5. Help Menu: On-line location sensitive help shall be provided for each menu item, describing the consequences of making the highlighted menu selection.

6. Programming Functions: The software blocks shall provide all the necessary mathematics, logic, utility, and control functions necessary for proper sequence of control. These functions shall be contained in the network controller operating system to be available in any combination for field programming the unit through RAM memory.
   a. Proportional, Integral plus Derivative Control (PID)
   b. Self-tuning PID
   c. Two position control
   d. Digital filter
   e. Ratio calculator
   f. Equipment cycling protection

7. Energy Management Applications: As a minimum, the network controller shall have the ability to, but not be limited to, perform energy management strategies such as:
   a. Time or event based scheduling
   b. Calendar/holiday based scheduling
   c. Temporary schedule overrides
   d. Adaptive optimum start/stop
   e. Chiller and boiler reset/optimization
   f. Demand limiting/load shedding
   g. Enthalpy switchover (economizer)
   h. Temperature compensated duty cycling
   i. CFM tracking
   j. Temperature or pressure reset
   k. Run time totalization
   l. Alarm detection and dial out or email out
   m. Night setback
   n. Historical trending

8. Alarms: The network controller shall be capable of comparing analog and digital readings to predetermined high and low limits and annunciate each time a value enters or returns from an alarm condition. Unique high and low limits shall be supplied for each analog point in the network. The network shall be capable of suppressing selected alarm reporting when the primary equipment from which the alarm point is based is in the inactive state. The alarm features of the system controller software shall, as a minimum, provide the following:
   a. Digital, analog, and hi/low settings and deadband
b. Sliding alarm limits  
c. Conditional alarming  
d. Alarm inhibiting through feedback loop  
e. Fluttering alarm suppression  
f. Separate tailored alarm messages of 70 characters each  
g. Auto dial of any user selected alarm condition to a minimum of 25 telephone numbers  
h. Auto email of any user selected alarm condition to a minimum of 25 email addresses

9. Trending: Each network controller shall have the capability to simultaneously trend a minimum of 60 combined points. Adjustable sampling intervals for each trend from 30 seconds to one day or on change of value/state shall be possible. Each trend shall be capable of being automatically started or stopped, based on time of day, externally sensed points, alarms, or a calculated value. Upload of trend data to the operator workstation or other memory storage device shall be automatically performed at any time during the sampling period. The uploaded trend data shall be fully compatible with Microsoft Excel.

10. On-Line Testing: The network shall have the capability to allow the operator to design, test, and implement desired control strategies on-line.

11. Communication Diagnostics: The network controller software shall be capable of self-diagnosing failure automatically without necessary query by the operator. In the event of communications failure or limited power failure, the network shall be capable of both notifying a local operator of the specific occurrence, as well as communicating to a remote operator, either by the internet or auto dialing/emailing the condition. In addition to automatic self-diagnostics, each network controller shall maintain communications statistics on local and application specific controller communications. These statistics shall tabulate total communications attempted versus successful and unsuccessful communications by unit number. An option shall exist to reset communications statistics to zero (0) at any time.

2.07 LOCAL CONTROLLERS

A. General: Each HVAC local controller shall be a stand-alone BAS controller. The local controllers shall be a local control loop microprocessor-based controller installed at each HVAC system (e.g. air handling unit, heating plant, chilled water plant). Each controller shall be fully programmable, contain its own control programs and will continue to operate in the event of a failure or communication loss to its associated network controller.

B. Each local controller provided must be a BACnet device, supporting the BACnet Advanced Application Controller (B-AAC) profile. Controllers that support a lesser profile such as B-ASC or B-SA are not acceptable. Local controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as Advanced Application Controller(B-AAC).

C. Hardware:

1. Operating Environment: The controller shall be capable of operating in an environment of 32 to 122 deg F and 10 to 90% relative humidity non-condensing.
2. Memory: Both the operating system of the controller, plus the application program for the controller, shall be stored in non-volatile, FLASH memory. Controllers shall contain enough memory for the current application plus required history logging. All controllers with volatile memory shall have a battery-backup for a minimum of 72 hours. Each controller shall be addressable by a workstation or laptop.
3. Isolation: Control, communication, and power circuits for each controller shall be individually electrically isolated to protect against transients, spikes, and power surges.
4. Input/Output Modules: Provide with at least the minimum quantity of inputs and outputs as required by the sequence of operations and points list.
   a. Analog inputs shall accept industry standard analog signals (4-20 mA, 0-5 VDC, 0-10 VDC, etc.).
   b. Binary inputs shall detect contact closures.
   c. Universal inputs shall have functionality as either an analog or binary input.
   d. Digital outputs may be latched or momentary contact type.
   e. Analog outputs shall have a 1% resolution over total output span of 100%.
   f. Configurable outputs shall have functionality as either an analog or binary output.

5. Expandability: Provide input and output expansion capability through the use of plug-in modules. At least two I/O expansion modules must be capable of being added to the base local controller.

D. Software: Provide complete controller software to execute all HVAC system local loop controls functions.

1. Control Parameters: The software blocks in the local controller shall produce all of the necessary reverse acting and/or direct acting PI signals as required by the control sequence. The proportional and integral values which make up the PI output value shall be readable and modifiable, at the system workstation or the portable service tool to facilitate tuning of control loops.

2. Networking: Each input, output, or calculation result shall be capable of being assigned to the system controller for system networking. The local controller shall also provide the ability to download and upload configuration data, both locally at the controller and via the BAS communications network.

3. Scan: Controller shall continuously scan and maintain the most recent data in RAM for retrieval by a network controller, operator interface, and by the local controller software programs.

4. Database: All field control databases shall be entered, changed or downloaded to the local controllers via a laptop or operator workstation.

5. Auto-Calibration: All inputs shall feature an auto-calibrate function to eliminate sensing errors.

6. Memory: Provide amount of memory required to store data until it is sent to the network controller.

7. Programming Functions: Provide the following standard BAS loop programming functions:
   a. Control block programming
   b. PI or PID control
   c. Serial load staging
   d. Binary load staging
   e. Analog load staging
   f. Master-submaster routines
   g. Anti-windup for integrated loops

8. Real Time Clock (RTC): All local controllers shall have a real time clock in either hardware or software. The accuracy shall be within 10 seconds per day. The RTC shall provide the following information: time of day, day, month, year, and day of week. Each local controller shall receive a signal, every hour, over the network from the network controller, which synchronizes all local controllers’ real time clocks.

E. Failure Operation:

1. Automatic Restart After Power Failure: Upon restoration of power after an outage, the controller shall automatically and without human intervention: update all monitored functions, resume operation based on current, synchronized time and status, and implement special start-up strategies as required.
2. Stand-Alone Operation During Network Communication Failure: Controllers requiring the application or database to be downloaded from a host or share processing with a network controller shall not be acceptable. During a communication failure the application specific controller must run the control application using the current setpoints and configuration.

3. Failure of any local controller shall register as an alarm in the BAS.

2.08 APPLICATION SPECIFIC CONTROLLERS

A. General: Each HVAC application specific controller shall be a stand-alone BAS controller. The controller shall include all hardware and software required for communications with the network controller. Unless noted otherwise, an individual application specific controller shall be dedicated for each terminal device.

B. Each application specific controller provided must be a BACnet device, supporting the BACnet Application Specific Controller (B-ASC) profile. Controllers that support a lesser profile such as B-SA are not acceptable. Local controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as Application Specific Controllers (B-ASC).

C. Hardware:

1. Operating Environment: The controller shall be capable of operating in an environment of 32 to 122 deg F and 10 to 90% relative humidity non-condensing.

2. Input/Output Modules: Provide with at least the minimum quantity of inputs and outputs as required by the sequence of operations and points list.
   a. Analog inputs shall accept industry standard analog signals (4-20 mA, 0-5 VDC, 0-10 VDC, etc.).
   b. Binary inputs shall detect contact closures.
   c. Universal inputs shall have functionality as either an analog or binary input.
   d. Digital outputs may be latched or momentary contact type.
   e. Analog outputs shall have a 1% resolution over total output span of 100%.
   f. Configurable outputs shall have functionality as either an analog or binary output.

3. Expandability: Provide input and output expansion capability through the use of plug-in modules. Where additional inputs or outputs are required for the specified application, provide the expansion module with the application specific controller.

D. Software:

1. Programming: The control program shall reside in the application specific controller. The application program shall be maintained in read only memory (ROM). The default database, i.e. setpoints and configuration information, shall be stored in electrically erasable programmable read-only memory (EEPROM). Controllers requiring local setting of potentiometers or dip switches are not acceptable for programming functions. Dip switches for creating unique addresses for controllers are acceptable.

2. Auto-Calibration: All inputs shall feature an auto-calibrate function to eliminate sensing errors.

E. Failure Operation:

1. Automatic Restart After Power Failure: Upon restoration of power after an outage, the controller shall automatically and without human intervention: update all monitored functions, resume operation based on current, synchronized time and status, and implement special start-up strategies as required.

2. Stand-Alone Operation During Network Communication Failure: Controllers requiring the application or database to be downloaded from a host or share processing with a network controller shall not be acceptable. During a communication failure the application specific controller must run the control application using the current setpoints and configuration.
3. Failure of any application specific controller shall register as an alarm in the BAS.

2.09 REPEATERS AND SIGNAL CONDITIONERS

A. Provide a repeaters and signal conditioners at locations in the controls network where required.

2.10 GATEWAYS

A. Provide a gateway at all points of connections of dissimilar controls networks/protocols. The gateway shall permit the exchange of all specified and required information between the two dissimilar networks/protocols.

2.11 FIELD DEVICES

A. Mutli-Purpose Sensors:

1. All mutli-purpose or combination sensors shall meet all requirements listed below for the individual sensors that are being combined into one unit.
2. Sensors are only allowed to be combined if shown in the exact same location on the controls schematics, HVAC plans, or elevations with no components between them.

B. Temperature Sensors:

1. General:
   a. All temperature devices shall use precision thermistors or RTD sensors accurate to +/- 1 degree F over a range of –30 to 230 degrees F, unless indicated otherwise.
2. Space Sensors and/or Thermostats:
   a. Sensors shall be available in an off-white ventilated enclosure, unless noted otherwise on the plans. Sensor shall be able to be mounted on a standard electrical box.
   b. Where indicated on the plans, the sensor housing shall feature both a mechanism for adjusting the space temperature set point and/or a push button for selecting after hours occupied operation.
   c. Where indicated on the plans, the sensor shall incorporate either an LED or LCD display for viewing the space temperature, set point, and other operator selectable parameters. Using built in buttons, operators shall be able to adjust set points directly from the sensor. Resolution shall be as indicated on the plans.
   d. Minimum sensing range shall be 32 to 100 deg. If a space is being controlled to a set point outside of this range, then a sensor appropriate for the application shall be provided.
   e. All sensors shall be the same appearance in the occupied and public areas of the building, but may have different options as required (set point adjustment, override button, etc.). Exceptions that would allow a different appearance include mechanical rooms, electrical rooms, storage rooms, vestibules, etc.

3. Duct Sensors: Sensors shall incorporate a thermistor bead embedded at the tip of a stainless steel tube. Wiring shall terminate in a galvanized steel box at the end of the probe, except where wiring factory provided wiring can be connected to a controller without additional wiring. Probe style duct sensors are required in air handling applications where the coil or duct area is less than 14 square feet.
   a. For duct widths 12” or less, use a minimum 4” probe.
   b. For duct widths between 13” and 24”, use a minimum 8” probe.
   c. For duct widths larger than 24”, use a minimum 12” probe.
4. Averaging Temperature Sensors: Sensors shall be employed in ducts which are larger than 14 square feet. The length of flexible copper tubing shall cover no more than one square foot of face area per one linear foot of sensing element length. The maximum length of the copper tube for one device shall be 24 ft. Where a longer length is required, multiple sensors shall be provided and the average temperature calculated by software programming.

5. Immersion Sensors: Sensors shall be employed for measurement of temperature in all hydronic, domestic water, and refrigerant piping applications. Thermal wells shall be brass or stainless steel for non-corrosive fluids below 250 degrees F and 300 series stainless steel for all other applications. Wiring shall terminate in a galvanized steel box at the end of the probe. The length of the probe shall extend into the pipe so the end of the probe is in the middle third of the pipe. Use for all water temperature sensors on all pipe sizes 2" and larger, unless indicated otherwise on the controls schematics.

6. Freezestats: Low limit temperature sensors with manual reset and capillary tube that senses the lowest temperature along the length of the capillary. The length of the capillary tube shall cover no more than one square foot of face area per one linear foot of capillary tube length. Where long lengths are required, provide multiple freezestats. The sensor shall be adjustable throughout the entire temperature range of 15 to 55 deg F.

7. Outdoor Air Sensors: Provide with weather shield to protect against solar radiation and precipitation with multiple discs to allow for good airflow. Minimum sensing range shall be from -40 to 140 deg F.

8. Slab Sensors: Sensor shall accurate measure temperatures below 40 deg F. Provide with an enclosure to be recessed into the slab.

C. Humidity Sensors:

1. Space Sensors:
   a. Humidity sensors shall be of the solid-state type using a hydroscopic polymer or thin film capacitive sensing element.
   b. Sensors shall be available in an off-white ventilated enclosure, unless noted otherwise on the plans. Sensor shall be able to be mounted on a standard electrical box.
   c. Accuracy: +/- 2% over a range of 0-90% non-condensing.
   d. Stability: +/- 1% annually over 2 years.

2. Duct and/or Air Moving Equipment Sensors:
   a. Humidity sensors shall be of the solid-state type using a hydroscopic polymer or thin film capacitive sensing element.
   b. Accuracy: +/- 2% over a range of 0-90% non-condensing.
   c. Stability: +/- 1% annually over 2 years.
   d. Where installed in high velocity ductwork, provide an element guard.

3. Outdoor Air Sensors:
   a. Provide with weather shield to protect against solar radiation and precipitation with multiple discs to allow for good airflow.
   b. Accuracy: +/- 2% over a range of 0-90% non-condensing.
   c. Stability: +/- 1% annually.

4. All humidity sensors shall be able to be recalibrated in the field or the sensing tip to be replaced without replacing the entire sensor.

D. Carbon Dioxide (CO2) Sensors:

2. Range: 0 – 2,000 ppm or 0 – 5,000 ppm as required based on the control and alarm concentrations indicated on the plans. If no concentrations are indicated, use 0 – 2,000 ppm.
3. Accuracy: +/- 2% of range or 2% of reading.
4. Stability: +/- 5% over 5 years.
5. Provide with one CO₂ calibration kit for the entire project. Kit shall include two 17-liter CO₂ calibration gas cylinders, one at 200 ppm and one at 1,000 ppm. Also provide a gas regulator, tubing, fittings, adapters, sensor cones, etc., as required for the application.

E. Differential Pressure Sensor: Differential pressure sensor shall be temperature compensated and shall vary the output voltage with a change in differential pressure. Sensor shall have a non-repeatability of +/- 0.05% of range. Sensor shall be capable of withstanding up to 150% of rated pressure without damage.

1. Duct differential pressure sensors shall have an appropriate range for the application with a minimum accuracy of +/- 1% of range.
   a. Sensors in positively pressurized ductwork (typically downstream of the supply fan) shall only have a positive range.
   b. Sensors in negatively pressurized ductwork (typically upstream of a fan) or between fans in series (typically in an air handling unit) shall have both a negative and positive range.
2. Room differential pressure sensors shall have a range of -0.25" w.c. to 0.25" w.c. and a minimum accuracy of +/- 0.5% of range.
3. Underfloor plenum differential pressure sensors shall have a range of 0" w.c. to 0.25" w.c. and a minimum accuracy of +/- 0.5% of range.
4. Building differential pressure sensors shall have a range of -0.25" w.c. to 0.25" w.c. and a minimum accuracy of +/- 0.5% of range. Sensor shall be provided with a pressure sensing tip that incorporates a shield to minimize the effect of wind.
5. Water differential pressure sensors shall be accurate to +/- 0.5% of range. The housing shall be NEMA 4 rated.
6. Steam and gas differential pressure sensors shall be accurate to +/- 0.5% of range. The housing shall be NEMA 4 rated.

F. Air Differential Pressure Switches: Differential pressure switches shall be field adjustable with a range appropriate for the duct pressure classification and include manual reset. The switch shall be capable of withstanding up to 150% of rated pressure without damage. Provide a red pilot lighted reset button located on the control panel that is wired to the manual reset from the switch.

G. Airflow Measuring Stations (AFMS):

1. General:
   a. All AFMSs shall be manufactured by Ebtron.
   b. Provide a thermal anemometer using instrument grade self-heated thermistor sensors with thermistor temperature sensors.
2. Duct-Mounted Air Flow Measuring Stations (Duct sizes 16" or less in any direction):
   a. Airflow measuring stations to be Ebtron Model ELF/F. Each device shall consist of two independent sensor nodes in a single probe assembly for ducts from 5" to 16" and a single sensor node for 4" ducts.
   b. Each sensing node shall independently determine the airflow rate, which shall be equally weighted in calculations by the transmitter prior to output as the average for the duct and be linear to flow.
   c. Each device shall have a certified accuracy of +/-3% of reading over the entire calibrated airflow range of 0 to 3,000 fpm, including repeatability of 0.25% of reading.
   d. Analog output resolution shall be equal to or better than 0.015% full-scale.
   e. Each device shall be individually wind tunnel calibrated as an assembly to volumetric airflow standards. The design shall include compensation for flow losses to eliminate inaccuracies associated with airflow measurement in small ducts.
f. Required Environmental Operating Range
   i. The transmitter operating temperature range shall be at least -20° F to 120° F.
   ii. The sensor probe operating temperature range shall be at least -20° F to 160° F.
   iii. The operating humidity range shall be at least 0 to 99% (non-condensing).

g. Probes shall be constructed of extruded 6063 aluminum tubes.

h. The transmitter shall be capable of field configuration and diagnostics and identifying a faulty sensor node, ignore it and continue to operate by correctly averaging the remaining sensor node.

3. Duct-Mounted Air Flow Measuring Stations (Duct sizes up to and including 2 square feet):
   a. Airflow measuring stations to be Ebtron Hybrid Series HTx104-P. Each device shall consist of four independent sensor nodes in a number of probes required for the application.
   b. Each sensing node shall independently determine the airflow rate, which shall be equally weighted in calculations by the transmitter prior to output as the average for the duct and be linear to flow.
   c. Each device shall have a certified accuracy of +/-2% of reading over the entire calibrated airflow range of 0 to 5,000 fpm, including repeatability of 0.25% of reading.
   d. Analog output resolution shall be equal to or better than 0.025% full-scale.
   e. Each device shall be individually wind tunnel calibrated as an assembly to volumetric airflow standards. The design shall include compensation for flow losses to eliminate inaccuracies associated with airflow measurement in small ducts.
   f. Required Environmental Operating Range
      i. The transmitter operating temperature range shall be at least -20° F to 120° F.
      ii. The sensor probe operating temperature range shall be at least -20° F to 160° F.
      iii. The operating humidity range shall be at least 0 to 99% (non-condensing).
   g. Probes shall be constructed of gold anodized extruded 6063 aluminum tubes.
   h. The transmitter shall be capable of field configuration and diagnostics and identifying a faulty sensor node, ignore it and continue to operate by correctly averaging the remaining sensor node.
   i. The transmitter shall be provided with a 16-character, alpha-numeric, LCD display. The airflow rate, temperature, airflow alarm and system status alarm shall be visible on the display.
   j. Provide with remote mounted display enclosure for mounting below 7 ft in the mechanical room.

4. Duct-Mounted Air Flow Measuring Stations (Duct sizes larger than 2 square feet):
   a. Airflow measuring stations to be Ebtron Gold Series GTx116-P+. Each device shall consist of up to 16 independent sensors in a number of probes required for the application. The quantity of nodes provided shall be according to the following table.

<table>
<thead>
<tr>
<th>Area ft²</th>
<th># Sensor Nodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 2 &amp; ≤ 4</td>
<td>6</td>
</tr>
</tbody>
</table>

   b. A total of 4 probes shall be required for openings with an aspect ratio ≥ 1.5 and with an area ≥ 25 ft².
c. Each sensing node shall independently determine the airflow rate, which shall be equally weighted in calculations by the transmitter prior to output as the average for the duct and be linear to flow.

d. Each device shall have a certified accuracy of +/-2% of reading over the entire calibrated airflow range of 0 to 5,000 fpm, including repeatability of 0.25% of reading.

e. Analog output resolution shall be equal to or better than 0.025% full-scale.

f. Each device shall be individually wind tunnel calibrated as an assembly to volumetric airflow standards. The design shall include compensation for flow losses to eliminate inaccuracies associated with airflow measurement in small ducts.

g. Required Environmental Operating Range

i. The transmitter operating temperature range shall be at least -20°F to 120°F.

ii. The sensor probe operating temperature range shall be at least -20°F to 160°F.

iii. The operating humidity range shall be at least 0 to 99% (non-condensing).

h. Probes shall be constructed of gold anodized extruded 6063 aluminum tubes.

i. The transmitter shall be capable of field configuration and diagnostics and identifying a faulty sensor node, ignore it and continue to operate by correctly averaging the remaining sensor node.

j. The transmitter shall be provided with a 16-character, alpha-numeric, LCD display. The airflow rate, temperature, airflow alarm and system status alarm shall be visible on the display.

k. Provide with remote mounted display enclosure for mounting below 7 ft in the mechanical room.

5. Fan Inlet Air Flow Measuring Stations:

a. Airflow measuring stations to be Ebtron Gold Series GTx108-F. The number of independent sensor nodes provided shall be as follows:

i. SWSI and DWDI fans: 2 probes x 1 sensor node/per probe in each fan inlet.

ii. Fan Arrays (2 to 4 fans): 2 probes x 1 sensor node per probe in each fan inlet.

iii. Fan Arrays (5 to 8 fans): 1 probe x 1 sensor node per probe in each fan inlet.

b. Each sensing node shall independently determine the airflow rate, which shall be equally weighted in calculations by the transmitter prior to output as the average for the duct and be linear to flow.

c. Each device shall have a certified accuracy of +/-2% of reading over the entire calibrated airflow range of 0 to 10,000 fpm, including repeatability of 0.25% of reading.

d. Analog output resolution shall be equal to or better than 0.025% full-scale.

e. Each device shall be individually wind tunnel calibrated as an assembly to volumetric airflow standards. The design shall include compensation for flow losses to eliminate inaccuracies associated with airflow measurement in small ducts.

f. Required Environmental Operating Range

i. The transmitter operating temperature range shall be at least -20°F to 120°F.

ii. The sensor probe operating temperature range shall be at least -20°F to 160°F.

iii. The operating humidity range shall be at least 0 to 99% (non-condensing).

Each sensor probe shall consist of one sensor node mounted on a 304 stainless steel block with two adjustable zinc plated steel rods connected to 304 stainless steel pivoting mounting feet.
h. The transmitter shall be capable of field configuration and diagnostics and identifying a faulty sensor node, ignore it and continue to operate by correctly averaging the remaining sensor node.

i. The transmitter shall be provided with a 16-character, alpha-numeric, LCD display. The airflow rate, temperature, airflow alarm and system status alarm shall be visible on the display.

j. Provide with remote mounted display enclosure for mounting below 7 ft in the mechanical room.

H. Water Flow Measuring Stations (WFMSs):

1. General:
   a. All WFMSs shall be manufactured by Onicon.

2. Inline Electromagnetic Flow Meter:
   a. Provide model F-3200.
   b. The flow station shall operate at +/-0.2% of reading from 1.6 to 33 ft/s of and +/-0.0033 ft/s from 0.033 to 1.6 ft/s.
   c. Provide meter liner of appropriate material based on the application. All heating hot water flow meters shall have a PTFE liner.
   d. Provide with remote mounted display enclosure for mounting below 7 ft in the mechanical room.

3. Insertion Electromagnetic Flow Meter:
   a. Provide model F-3500.
   b. The flow station shall operate at +1% of reading from 2 to 20 ft/sec and +0.02 ft/sec from 0.1 to 2 ft/sec.
   c. Unit shall be removable by hand without system shutdown or drain.

I. BTU Meters:

1. All BTU meters shall be manufactured by Onicon and be paired with an Onicon flow meter and Onicon temperature sensors. All components shall come as a packaged, calibrated system.

2. Provide model System-10 BTU meter with display.

3. Provide with a BACnet communication protocol.

J. Control Valves:

1. General:
   a. Refer to section 23 0523 – General Duty Valves for HVAC for valve construction and application requirements, unless noted otherwise below.
   b. Valves shall be packless and electrically actuated with true linear flow characteristics in relationship to valve opening.
   c. Valves shall meet the heating and cooling flow rates specified and close off against the differential pressure conditions for the system in which it is installed.
   d. Valves should be sized to operate accurately and with stability from 10 to 100% of the maximum design flow.

2. Hydronic Systems:
   a. Valves with a modulating actuator shall be sized for a 3 to 5 psi pressure drop at the design flow rate.
   b. Valve shall be 2-way or 3-way as indicated on the plans. If there is no indication, the valve shall be 2-way.
   c. Pressure Independent Control Valves:
      i. The flow through the valve shall not vary more than +/-5% due to system pressure fluctuations.
      ii. The rangeability of the control valve shall be a minimum of 100 to 1.
iii. Each valve shall be provided with p/t ports on the inlet and outlet of the valve.
iv. A flow tag shall be provided with each valve.

K. Valve Actuators:

1. Actuators shall be electronic and shall be direct coupled over the shaft, without the need for connecting linkage.
2. Actuator shall have electronic overload circuitry to prevent damage.
3. Actuators shall be available with spring return to the normal position when required or as indicated on the plans.
4. Actuators shall have a position indicator for external indication of valve position.
5. Actuators shall have manual override capability.
6. Actuators shall be quick opening or slow opening as required by the application.
7. Actuators shall be able to completely close the valve against system pressure.
8. Actuators shall be two-position or modulating as required by the sequence of operations.
9. Actuators shall be compatible with the type of valve as indicated on the plans or elsewhere in the specifications (e.g. two-way vs. three-way, ball vs. butterfly, etc.).

L. Control Dampers:

1. Damper frames are to be constructed of minimum 13 gauge metal with linkage concealed in the side channel. Provide with compressible spring stainless steel side seals and self-lubricating bearings.
2. Damper blade width shall not exceed 8 inches and the blade length shall not exceed 48 inches. Damper blades shall have an airfoil profile to minimize pressure drop through the damper. Seals shall be butyl-rubber or EPDM and are required at the ends of the blades.
3. Provide opposed blade dampers for modulating applications and parallel blade for two-position control.
4. Damper shall be constructed of the same material as the duct in which it will be installed, except as noted below:
   a. Dampers in exhaust or outdoor air ducts shall be aluminum
5. Dampers in exhaust or outdoor air ducts shall have insulated blades and completely thermally broken construction.
6. Where damper shafts penetrate the damper housing, it shall be sealed while allowing the free movement of the shaft without breaking the seal.
7. Damper shall be ultra-low leakage rated as Class 1A at 1” w.c. and Class 1 at 4” w.c. as defined by AMCA 500.
8. Dampers that are indicated to close completely by the sequence of operations shall be provided with flanged connections.

M. Damper Actuators:

1. Actuators shall be electronic and shall be direct coupled over the shaft, without the need for connecting linkage.
2. Actuators shall have electronic overload circuitry to prevent damage.
3. Actuators shall be available with spring return to the normal position when required or as indicated on the plans.
4. Actuators shall have a position indicator for external indication of damper position.
5. Actuators shall have manual override capability without disconnecting damper linkage.
6. Actuators shall be quick opening or slow opening as required by the application.
7. Actuators shall be able to completely close the damper against system pressure.
8. Actuators shall be two-position or modulating as required by the sequence of operations.
9. Provide the appropriate quantity of damper actuators as required by the application.
N. Position Switches: Provide switch that can sense the full closed position and an adjustable open position between 10 and 100%.

O. Current Switches: Current status switches shall be used to monitor motors and other electrical loads as indicated on the plans. Current switches shall be available in solid and split core models and offer either a digital or an analog signal to the automation system. The sensing range of the sensor shall be appropriate for the device being monitored.

P. Audible and Visible Alarms: Horn shall be continuous tone with solid-state electric signal and red LED pilot light. Provide a separate silence button (refer to manual push buttons below) to be mounted at an accessible height. The light shall remain on and the alarm condition active even after the silence button is pressed until the alarm state is resolved.

Q. Pilot Lights: Light shall be LED type with push-to-test function and have an oil-tight enclosure. The light shall be green when indicating normal operation and red when indicating an issue or alarm.

R. Manual Push Buttons: Button shall be round, approximately 3/4" in diameter. Provide with the quantity and type of contacts required for the application. Submit color options for selection by the Design Professional during submittal review.

S. Manual Switches: Provide line-voltage toggle switch appropriate for the application. Refer to Division 26.

2.12 CONTROL WIRING

A. The term "control wiring" is defined to include providing of wire, conduit, junction boxes, and miscellaneous materials as required for mounting and connecting electric or electronic control devices and network communication devices.

B. All control wiring and wiring connections required for the installation of the BAS system shall be provided by BAS Contractor unless specifically shown on the electrical or telecommunication drawings or called for in Division 26 or Division 27.

C. All control wiring shall comply with the requirements of local and national electrical codes.

D. Control wiring in ducts, air plenums, air moving equipment, and other air handling spaces shall be specifically listed for the use, including wiring provided with field devices.

PART 3 - EXECUTION

3.01 GENERAL

A. Inspect and examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the installer.

B. Install systems and materials in accordance with drawings and details, manufacturer's instructions, reviewed submittals, and contract documents. Install electrical components and use electrical products complying with requirements of applicable Division-26 sections of these specifications.

C. Where components are installed in potentially wet or corrosive environments, install in an appropriate enclosure. Enclosures shall be of the type as indicated:
   1. Components installed in exterior locations or locations subject to moisture shall be installed in a NEMA 4 enclosure.
3.02 INSTALLATION OF CONTROLLERS

A. Install controllers in accordance with manufacturer’s installation instructions and with adequate clearance to allow for maintenance.

B. Install all controllers in a control panel enclosure. Control panels shall be of the type as indicated:
   1. Controllers installed in interior locations shall be installed in a NEMA 1 enclosure.
   2. Controllers installed in exterior locations or locations subject to moisture shall be installed in a NEMA 4 enclosure.

C. Label all control panel enclosures with the system or equipment served. Network controllers shall be labeled to indicate the general areas of the building served. All labels shall match the designations on the as-built drawings, which shall match the equipment tags on the plans.

D. Include a copy of the as-built point-to-point wiring diagrams and final programmed sequence inside each control panel enclosure.

3.03 INSTALLATION OF FIELD DEVICES

A. General:
   1. Install all field devices where indicated on the plans and in accordance with manufacturer’s installation instructions and with adequate clearance to allow for proper operation, maintenance, and removal of the device.
   2. Repair pipe insulation to maintain the integrity of the insulation vapor barrier. Use hydraulic insulating cement to fill voids and to repair damages to the factory applied vapor barrier. Finish with material matching or compatible with adjacent jacket material.
   3. Repair duct insulation to maintain the integrity of the insulation vapor barrier. Use foil tape to repair damages to the factory applied vapor barrier.
   4. Where a field device penetrates a duct or air moving equipment, seal around the penetration to prevent air leakage.

B. Room/Wall-mounted Sensors: Install at the elevation indicated on the plans. Install plastic guards over sensors with user adjustment where noted on the plans.

C. Temperature Sensors:
   1. Averaging Temperature Sensors: Install sensing element with equal spacing to provide uniform coverage of the face area.
   2. Immersion Sensors: Coordinate the pipe size required to accept the probe diameter of the sensor without significant flow restriction with the HVAC and Plumbing Piping Contractor. All probes shall be installed in a minimum 1-1/4" pipe size.
   3. Pipe Surface Mount Temperature Sensors (Strap-on): Use only where specifically indicated on the plans. Install with thermally conductive paste at the pipe contact point. Where sensor is to be installed on an insulated pipe, install probe under the insulation and secure around pipe with only the wire protruding from insulation. Seal around wiring to maintain the vapor barrier of the pipe insulation.
   4. Freezestat: Install sensing element with equal spacing to provide uniform coverage of the face area. Adjust the low limit temperature setting as indicated on the plans or as required for the application.
   5. Outdoor Air Temperature and/or Humidity Sensors: Install in the location shown on the plans. If not shown on the plans, contact the Design Professional.
   6. Slab Sensors: Install sensor centered between parallel runs of tubing that are spaced at the typical design spacing. Locate sensor away from high foot traffic areas and away from paths of vehicular travel.
D. Duct-mounted Relative Humidity Sensors: When installed downstream of a humidifier, install far enough downstream in airflow path to allow for full moisture absorption into the airstream at all operating conditions of the humidifier. When element guard is provided with the sensor, install upstream of the sensor.

E. CO₂ Sensors: Within one month prior to project substantial completion, calibrate all sensors. Provide calibration reports as part of the closeout documents.

F. Occupancy Sensors: Wire to the extra contact on the occupancy sensor/room lighting controller provided by the Electrical Contractor.

G. Differential Pressure Sensors:
   1. Duct Differential Pressure Sensors: Install in the location in the system shown on the plans. If not shown on the plans, contact the Design Professional.
   2. Water Differential Pressure Sensors: Install in the location in the system shown on the plans. If not shown on the plans, contact the Design Professional.
   3. Building Differential Pressure Sensors: Install in the location shown on the plans. Where not shown on the plans, contact the Design Professional.

H. Air Differential Pressure Switches: For a positively pressurized duct, adjust the set point to be 0.25" less than the duct pressure classification rating. For a negatively pressurized duct, adjust the set point to be 0.25" more than the duct pressure classification rating. Unless indicated otherwise on the plans. Refer to the Duct Classification Schedule on the plans for duct pressure classification ratings.

I. Airflow Measuring Stations (AFMS):
   1. Duct-mounted: Install in an unobstructed straight length of duct in accordance with the manufacturer’s recommendations based on the duct fittings immediately upstream and downstream of the unobstructed straight length of duct.
   2. Fan inlet: Install one per fan where indicated on the plans.
   3. Where the AFMS comes with a remotely mounted display and the sensor is located in a mechanical room, the display shall also be located in the mechanical room. If the AFMS is located above a ceiling or in an occupied space, the display shall be located in the nearest mechanical, electrical, or custodial room, provided the distance is does not exceed the maximum allowed by the manufacturer. Mount the display within 7 ft AFF.
   4. If the AFMS is an insertion probe-type, install in a location with enough clearance to fully remove the probe from the duct.

J. Water Flow Measuring Stations (WFMS)
   1. Install in an unobstructed straight length of pipe in accordance with the manufacturer’s recommendations based on the pipe fittings immediately upstream and downstream of the unobstructed straight length of pipe.
   2. If the WFMS is an insertion-type, install in a location with enough clearance to fully remove the sensor from the pipe.

K. BTU Meter: Install meter so the display is within 7 ft of the floor. If the BTU meter is located above a ceiling or in an occupied space, the display shall be located in the nearest mechanical, electrical, or custodial room, provided the distance is does not exceed the maximum allowed by the manufacturer.
L. Control Valves: Install so that the valve stem axis is vertical, with operator side up. Where vertical stem position is not possible, or would result in poor access, valves may be installed with stem horizontal. Do not install valves with stem below horizontal or down.

M. Current Switch: Adjust so that the set point is below the minimum operating current and above motor no load current.

N. Wall-mounted Audible and Visible Alarms: Install device at 6'-8” above finished floor. Install silence button at 46” AFF and below the audible and visible alarm.

O. Wall-mounted Push Buttons: Install at the elevation indicated on the plans.

### 3.04 INSTALLATION OF CONTROL WIRING

A. The BAS Contractor may use the building telecommunications network for Tier 1 level communication between network controllers. The BAS Contractor shall utilize the data ports indicated specifically for BAS use on the telecommunications plans. If any additional or relocated data ports are required based on the BAS Contractor’s system layout, the BAS Contractor shall hire the Telecommunications Contractor to provide the additional data ports at no cost to the Owner.

B. Any equipment specified to be on emergency power shall also have all associated controls on emergency power, including all network controllers, local controllers, devices, etc.

C. Control wiring shall be routed in blue conduit in the following locations: concealed in walls, concealed above inaccessible ceilings, finished areas with exposed structure, inside air moving equipment or ductwork, locations subject to moisture, exterior locations, and in all unfinished spaces, such as mechanical rooms, electrical rooms, etc. Where conduit is in an exterior location or subject to moisture, it shall be rigid and sealed to be water tight. Control wiring shall not share conduit with line voltage wiring.

D. Control wiring routed to devices in accessible locations may be routed in flexible conduit. The minimum size of the flexible conduit shall be 1/2” and the maximum length shall be 36”.

E. Control wiring concealed by accessible construction may be installed without conduit. Accessible locations include areas such as above accessible ceilings and below accessible floors. Control wiring shall not share cable tray with telecommunications wiring or raceways with any other trade. All wiring shall be neatly routed and tie-wrapped to structural components, supported at least every 4 feet. Excess wire shall be neatly coiled and secured to structure. Under no circumstances shall cable be supported by piping, conduit, ductwork, ceiling tile or ceiling support wires. Cable shall be neatly routed in line with building lines.

F. Install all control wiring to meet all manufacturer installation requirements, including not exceeding the maximum cable length, tension, or bend radius. At all building expansion joints, provide means for movement of wiring and conduit that exceeds the expected movement of the building.

G. Label or color code each control wire at each end. Permanently label or code each point of all field terminal strips to show the instrument or item served. Color coded cable with cable diagrams may be used to accomplish cable identification.

H. Splices shall not be made in shielded wiring.
3.05 SYSTEM ACCEPTANCE

A. System Verification and Testing Procedure: The BAS Contractor shall confirm the system is complete, including all controls installed, graphics complete, and software programs have been completely tested and exercised for proper equipment operation. BAS control panels shall be demonstrated via a functional end to end test such that:

1. All output channels shall be commanded (on/off, stop/start, adjust, etc.) and their operation verified.
2. All analog input channels shall be verified for proper operation.
3. All binary input channels shall be verified by changing the state of the field device and observing the appropriate change of displayed value.
4. If a point should fail testing, perform necessary repair action and retest failed point and all interlocked points.
5. Automatic control operation shall be verified by introducing an error into the system and observing the proper corrective system response.
6. Selected time and setpoint schedules shall be verified by changing the schedule and observing the correct response on the controlled outputs.

B. System Demonstration: After the BAS Contractor has confirmed proper operation, acceptance testing will commence at a mutually agreeable time within ten (10) calendar days of the request. At that time, the BAS Contractor shall demonstrate the operation of the system to the Owner's Representative and Design Professional. Any issues are discovered during this demonstration shall be corrected.

C. Operation and Maintenance Manuals: Submit copies of operation and maintenance manuals as required by this section and section 23 00 10 – HVAC General Provisions.

END OF SECTION 23 09 00
SECTION 23 21 13 - HYDRONIC PIPING

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Contractor shall furnish all equipment, materials, tools, labor and supervision necessary to fabricate and install complete piping system as required by the drawings and this section.

1. Extent of hydronic piping work is indicated on drawings and schedules, and by requirements of this section.

2. Insulation of hydronic piping is specified in other Division-23 sections, and is included as work of this section.

3. Installation of valves for hydronic piping system is specified in other Division-23 sections and is included as work of this section.

1.03 QUALITY ASSURANCE

A. ASME Compliance: Fabricate and install hydronic piping in accordance with ASME B31.9 "Building Services Piping".

B. UMC Compliance: Fabricate and install hydronic piping in accordance with the "Uniform Mechanical Code".

C. IMC Compliance: Fabricate and install hydronic piping in accordance with the "International Mechanical Code".

1.04 SUBMITTALS

A. Submit manufacturer's material data and installation methods for each mechanical grooved and roll grooved piping system to be provided.

B. Submit manufacturer’s catalog cuts for each type of device to be used.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Grooved Piping Systems

1. Gruvlok by Anvil International
2. Victaulic

B. Copper Pressure-Seal Fittings

1. Viega Pro Press
2. NIBCO Press System
C. Fiberglass Reinforced Plastic (FRP) Pipe
   1. FGS Smith Fibercast

D. Expansion tanks
   1. Amtrol/Thrush
   2. Bell & Gossett
   3. Taco
   4. Wheatley
   5. Spirotherm
   6. Armstrong
   7. Patterson Pump

E. System fill pressure valve, air vents and other hydronic accessories
   1. Amtrol/Thrush
   2. Bell & Gossett
   3. Taco
   4. Wheatley
   5. Armstrong
   6. Patterson Pump

F. Air and Air/Dirt Separator
   1. Spirotherm
   2. Thrush
   3. Wheatly
   4. Bell & Gossett
   5. Taco
   6. Armstrong

G. Automatic Flow Control Valves
   1. IMI Flow Design Inc. (Autoflow)
   2. Griswold
   3. Pro Hydronic Specialties
   4. HCI Terminator

H. Strainers
   1. IMI Flow Design Inc. (Autoflow)
   2. SF Equipment
   3. Griswold
   4. Pro Hydronic Specialties

J. Glycol Make-Up Package
   1. Wessels
   2. General Treatment Products
   3. JL Wingert

K. Glycol
   1. Dow Chemical
   2. Houghton Chemical
   3. Envirogard
L. Triple Duty Valve
   1. Amtrol/Thrush
   2. Bell & Gossett
   3. Taco
   4. Armstrong
   5. Paco
   6. Patterson Pump

M. Backflow Preventers
   1. Hersey-Beeco
   2. Watts-Regulator
   3. Apollo Valves

N. Water Meters
   1. Badger
   2. Neptune

2.02 BASIC MATERIALS AND PRODUCTS

A. General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide materials and products complying with ASME B31.9 "Code For Building Services Piping" where applicable, base pressure rating on hydronic piping system's maximum design pressures. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in hydronic piping systems. Where more than one type of materials or products are indicated, selection is Installer's option.

B. Valves: Refer to Section 23 05 23 - General Duty Valves for HVAC Piping.

C. Piping Specialties: Refer to Section - 23 05 00 - Common Work Results for HVAC.

D. Expansion Compensation: Refer to Section 23 0516 - Expansion Fittings and Loops for HVAC Piping.

E. Meters and Gauges: Refer to Section 23 0519 - Meters and Gages for HVAC Piping.

F. Supports, Anchors and Seals: Refer to Section 23 0529 - Hangers and Supports for HVAC Piping.

2.03 PIPE:

<table>
<thead>
<tr>
<th>Material</th>
<th>Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type L</td>
<td>Above ground condensate drain lines. As permitted by local code.</td>
</tr>
</tbody>
</table>
B. Black steel pipe, Schedule 40, ASTM A53*
   Heat pump water. Heating water. Chilled water.
   Heat pump water and Chilled/Heating water 2" and larger.

C. Fiberglass Reinforced Plastic (FRP) Red Thread II Piping System
   Heat pump water and Chilled/Heating water
   Chilled/Heating water where threaded fittings are used.

D. Black steel pipe, Schedule 80, ASTM A53*

* ASTM A53 is for normal use only.

2.04 FITTINGS:

A. Copper water tube cast bronze or wrought copper:
   2. Pressure-Seal pipe joining system, copper press fittings, 1/2" to 4" in diameter. ASME B16.18, ASME B16.22. O-rings for copper press fittings shall be EPDM. Installation per manufacturer's recommendations.
   3. Mechanical grooved and roll-groove copper piping system and fittings: may be used as approved by code for copper piping. All components shall be by one manufacturer. System installation shall be in accordance with the manufacturer's recommendations.

B. Steel Pipe:
   1. Threaded pipe (2" dia and smaller): Malleable iron fittings, 125 pound standard flat band water pattern.
   2. Welded pipe (2 1/2" dia and larger): Standard radius weld fittings and weld neck or slip-on flanges, same material and strength as pipe.
   3. Mechanical grooved and roll-groove steel piping system and fittings: May be used as approved by code for black steel, stainless steel and galvanized steel. Gasket type to be used shall be appropriate for intended service. All components shall be by one manufacturer. System installation shall be in accordance with the manufacturer's recommendations.

C. Fiberglass Pipe:
   1. Fittings shall be manufactured using the same type material as the pipe. Fittings may be manufactured either by compression molding or spray-up/contact molding methods.
   2. Fittings shall be adhesive bonded matched tapered bell and spigot, threaded or grooved adapters, or flanged. Fittings shall be certified to ASTM D5685.
   3. Adhesive shall be manufacturer's standard for the piping system specified.

2.05 JOINTS

A. Copper water tube:
   1. Use non-corrosive 95-5 tin-antimony solder, cut pipe square, clean, ream and polish tube ends and inner surfaces of fittings, apply flux and solder joint as recommended by manufacturer of solder type fittings.
   2. Pressure-Seal pipe joining system, copper press fittings, 1/2" to 4" in diameter. ASME B16.18, ASME B16.22. O-rings for copper press fittings shall be EPDM.
   3. Mechanical grooved and roll grooved couplings: Grooved couplings may be used as approved by code for copper piping. Gasket type to be used shall be appropriate for intended service. All components shall be by one manufacturer. System installation shall be in accordance with the manufacturer's recommendations.
B. Steel Pipe:

1. Threaded pipe (2" dia and smaller): Make joints using Teflon tape applied to male threads only. Cut pipe square, cut threads clean, remove burrs and ream ends to full size of bore. For fuel piping and lubricating oil piping, joint sealing material shall be resistant to petroleum products.

2. Welded pipe (2 1/2" dia and larger): Welding shall conform to welding section of ANSI-B31.3 "Code for Power Piping."

3. Mechanical grooved and roll grooved couplings: Grooved couplings may be used as approved by code for black steel, stainless steel and galvanized steel piping. Gasket type to be used shall be appropriate for intended service. All components shall be by one manufacturer. System installation shall be in accordance with the manufacturer's recommendations.

C. Fiberglass Pipe:

1. Fittings shall be adhesive bonded matched tapered bell and spigot, threaded or grooved adapters, or flanged. Fittings shall be certified to ASTM D5685.

2. Adhesive shall be manufacturer's standard for the piping system specified.

2.06 NIPPLES AND UNIONS

A. All nipples shall conform to size, weight and strength of adjoining pipe. When length of unthreaded portion of nipple is less than 1-1/2", use extra strong nipple; do not use close nipples.

B. For pipe 2" and smaller, use screwed unions, for pipe 2-1/2" and over use flanged unions. For steel pipe use black or galvanized malleable iron unions, to conform to pipe with ground joint. Cast iron flanged unions gasket type.

C. Install unions in the following locations so that a minimum amount of pipe need be disassembled:

1. Long runs, at intervals of 80 feet.
2. In by-pass around equipment, valves, and controls.
3. In connections to equipment.
4. Where indicated on drawings.

D. Dielectric unions shall be installed between any connection of copper pipe and ferrous piping or equipment. In grooved piping systems, provide Clearflo by Victaulic.

2.07 EXPANSION TANKS

A. Furnish and install pre-charged steel expansion tanks as indicated on plans. Tanks shall have integral heavy duty Butyl rubber diaphragm, NPT system connection(s), and a .302"-32 charging valve connection (standard tire valve) to facilitate the on-site charging of the tank to meet system requirements. The tank shall be constructed in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code and stamped 125 PSI working pressure.

2.08 AIR AND DIRT SEPARATOR

A. Furnish and install units as indicated on plans. Air and dirt removal device shall be constructed of steel and shall be designed, fabricated and stamped per ASME Section VIII Division 1 with a maximum working pressure of 150 psi at 270 deg. F.
B. Units up to three inch size shall be provided with threaded connections as standard. Units four inch and larger shall be provided with flanged system connections as standard. Inlet and outlet connections to be inline with piping system, both inlet and outlet to be in the same horizontal and vertical planes.

C. Each air and dirt removal device shall be equipped with a brass conical shaped air venting chamber designed to minimize system fluid from fouling the venting assembly.

D. A brass flushing cock shall be located on the side of each separator to facilitate system fast-fill and removal of the floating impurities from the air system interface within the separator.

E. A blow down valve shall be provided by the unit manufacturer on the bottom of each unit to allow blow down and cleaning. On units 2-1/2” and smaller the valve and all of its fittings shall be 1”. On units 3” and larger the valve and all openings shall be 2”.

F. The air and dirt removal device shall remove air down to 18 microns and shall remove dirt/debris down to 35 microns. The unit shall be 100% efficient at removing dirt down to 90 microns in 100 passes or less.

2.08 SYSTEM FILL PRESSURE VALVE

A. Iron body, brass trim with field adjustable pressure setting. Bell & Gossett Model No. 12.

2.09 AIR VENTS

A. Automatic Air Vents: Bell & Gossett Model No. 7.

2.10 PRESSURE & TEMPERATURE TEST STATIONS

A. Supply and install in an accessible position, Peterson Equipment Company #110 "Pete's Plug", or equal, 1/4” MPT fitting ("110-XL for insulated piping) to receive either a temperature or pressure probe 1/8” O. D. in the supply and return piping of all chillers, coils, fan coil units, heat exchangers, water pumps, and on all hot water and chilled water, supply and return mains. Fitting shall be solid brass with two (2) valve cores or Nordel (maximum 275 deg. F. at 500 PSI), fitted with a color coded and marked cap with gasket and shall be rated at 1000 PSIG. Single valve core or Neoprene valve core devices are unacceptable.

B. Meters and Instruments - The installing contractor shall supply and present to the owner upon completion of testing, one Series 1500-XL pressure and temperature test kit, consisting of a 0-100 PSI, 0-230 ft. of water pressure gauge with No. 500 gauge adapter attached, a 25-125 deg. F. pocket testing thermometer, a 0-220 deg. F. pocket testing thermometer, a No. 500 gauge adapter, and a protective carrying case.

2.11 AUTOMATIC FLOW CONTROL VALVES

A. General: Contractor shall install automatic pressure compensating flow control valves where indicated on the details on the drawings. Provide with integral ball valve equal to Autoflow Model AC. Valves shall have the capacities and pressure differential characteristics as indicated and conform to the following specifications:

1. Valves shall be factory set and shall automatically limit the rate of flow to required engineered capacity within +/- 5% accuracy over an operating pressure differential of at least 14 times the minimum required for control.
2. The control mechanism of the valve shall consist of a self-contained, open-chamber cartridge assembly with unobstructed flow passages that eliminate accumulation of particles and debris. All internal working parts shall be passivated stainless steel.

3. The cartridge assembly shall consist of a spring-loaded cup. The cup shall be guided at two points and shall utilize the full available differential pressure across the valve to actuate the cup and thereby reduce friction and hysteresis and eliminate binding. It shall have a thin orifice plate and self cleaning of the variable inlet ports over the full control range.

4. Valves shall provide control over a minimum range of 2 psig to 32 psig. Valve bodies shall be rated for use at not less than 150% of system designed operating pressures.

5. Certified performance data for the flow control valve, based on independent laboratory tests, supervised and witnessed by a registered professional engineer, shall be available.

6. All flow control valves shall be supplied by a single source responsibility.

7. Each automatic flow control valve shall be furnished with two extended Pete's Plug temperature/pressure test ports.

8. Provide identification, both a metal identification tag, with chain, and a label on the valve for each installed valve. The identification shall provide zone identification, valve model number, rated flow in GPM and differential pressure range.

9. Valves installed on chilled water and two-pipe cooling/heating water systems to be provided with valve handle extension.

10. Provide replacement cartridges for up to 10% of units as required to adjust flow or pressure range during balancing.

2.12 STRAINERS

A. Strainers shall be combination valve, Y-strainer and union with two extended temperature/pressure test ports and hose end drain valve with cap and chain.

B. Strainers shall be equal to Autoflow Model YC as indicated on details and drawings. Y-strainers shall be 20 mesh stainless screen with removable cap.

C. Valves:

1. Two inches and smaller: Ball valves (see Section 23 05 23 - General Duty Valves for HVAC Piping).

2. Larger than two inches: Butterfly valves (see Section 23 05 23 - General Duty Valves for HVAC Piping).

2.13 WATER METERS (HYDRONIC SYSTEM MAKE UP)

A. Lead-Free bronze body with sealed register, manual water meter for monitoring hydronic system make-up supply line. Meter shall meet all applicable AWWA standards for installation in potable water system.
2.14 SUPPLY AND RETURN HOSES

A. All hoses shall be a minimum of 12 inches in length and equipped with swivel end connections at terminal unit. All end connections shall be crimped to meet stated pressure ratings. Serrated/slip fit connections are not acceptable.

B. Hose materials shall be high quality polyethylene pipe insulation over a stainless steel braided inner core and withstand working pressure of 375 PSI (1/2"), 300 PSI (3/4"), 225 PSI (1"), 200 PSI (1-1/4") at 211 deg. F and 175 PSI (1-1/2") and 150 PSI (2") at 200 deg. F.

2.15 SIDE STREAM FILTER

A. Housing
   1. Type 316 stainless steel construction with 2" ANSI flange connections, nitrile gasket and support legs.

B. Filter
   1. Polypropylene Media and Polypopylene cap, 27.8", 25 micron filtration with open connection style.

2.16 GLYCOL MAKE-UP SYSTEM

A. Provide fully automated and autonomous glycol make-up package mounted on a sturdy steel frame with 1/2" system connection and factory preset 12 psig (field adjustable) discharge for each glycol system.

B. Package shall be equal to Wessels Model GMP-13050 with the following features:
   1. Low level cut-off and alarm arrangement including a 110V signal for remote alarm.
   2. Isolation valves.
   3. Strainer.
   4. Pressure tank with pressure control.
   5. Pressure reducing valve and gauge.
   6. Translucent polyethylene solution container with lid designed to accommodate relief valve piping.
   7. Magnetic starter.
   8. 110V, 60 Hz motor and controls.

C. As an accessory to the glycol make-up system, provide a 5 gallon bypass filter/feeder with strainer and 25 micron filter. Filter/feeder shall be installed at a height for convenient access. The bypass feeder, 3/4" inlet and outlet gate valves, 1/2" drain valve, reducing tee, unions and nipples provided shall be suitable for use at 125 psig.

2.17 GLYCOL

A. Propylene Glycol
   1. The fluid shall be industrially inhibited propylene glycol (phosphate-based).
   2. The fluid shall be easily analyzed for glycol concentration and inhibitor level, and easily reinhibited using inhibitors readily available from the fluid manufacturer.
   3. If the system contains more than 250 gallons of fluid, annual analysis shall be provided free of charge by the fluid manufacturer. Manufacturer shall also market convenient analytical test aids for use by the operator of a smaller system.
4. The fluid must pass ASTM D1384 (less than 0.5 mils penetration per year for all system metals).

5. The fluid shall meet Iowa DNR requirements for geothermal heat pump applications.

6. Provide solution premixed with deionized water to maintain 25% concentration.

2.18 BACKFLOW PREVENTERS

A. Reduced Pressure Zone Backflow Preventer: A reduced pressure zone backflow preventer shall be installed at each cross connection or at the water meter to prevent back-siphonage and backpressure backflow of hazardous materials into the potable water supply. The device shall consist of a pressure differential relief valve located in a zone between two positive seating check valves. The assembly shall include two tightly closing shut-off valves before and after the device, test cocks and a protective strainer upstream of the No. 1 shut-off valve. The reduced pressure zone backflow preventer shall have all access port covers secured with stainless steel screws which are bolted to valve body. Vent outlet to have suitable connections for an air gap. The device shall meet the requirements of ANSI/ASSE Standard 1013 and AWWA Standard C506, be listed by IAPMO (UPC) and be approved by FCCCHR at USC. Watts Regulator Co. Series 009 - size 3/4" thru 2". Provide with air gap fitting for discharge.

PART 3 - EXECUTION

3.01 INSPECTION

A. General: Examine areas and conditions under which hydronic piping systems materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.02 INSTALLATION OF BASIC MATERIALS AND PRODUCTS

A. General: Install basic materials and products as required per manufacturer's recommendations, ASME B31.9 "Code for Building Services Piping", and as required to meet the intent of the documents.

B. Valves

1. Refer to Section 23 05 23 - General Duty Valves for HVAC Piping.

2. Locate valves for easy access and operation. Do not locate valves with stems below horizontal.

3. Sectional Valves: Install on each branch and riser, close to main, where branch or riser serves 2 or more hydronic terminals or equipment connections, and elsewhere as indicated.

4. Shutoff Valves: Install on inlet and outlet of each mechanical equipment item, and on inlet of each hydronic terminal, and elsewhere as indicated.

5. Drain Valves: Install on each mechanical equipment item located to completely drain equipment for service or repair. Install at base of each riser, at base of each rise or drop in piping system, and elsewhere where indicated or required to completely drain hydronic piping system.

6. Check Valves: Install on discharge side of each pump, and elsewhere as indicated.
C. Piping Specialties: Refer to Section 23 05 00 - Common Work Results for HVAC.

D. Expansion Compensation Products: Refer to Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping.

E. Meters and Gauges: Refer to Section 23 05 19 - Meters and Gages for HVAC Piping.

F. Supports, Anchors and Seals: Refer to Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.

3.03 HYDRONIC PIPING

A. Install pipe for all hydronic systems as indicated on drawings, as called for in other sections, and as specified herein.

B. Arrange and install piping approximately as indicated; straight, plumb, and as direct as possible; form right angles on parallel lines with building walls. Keep pipes close to walls and avoid interference with other trades. Locate groups of pipes parallel to each other; space at a distance to permit applying full insulation and to permit access for servicing valves. Most piping to be run in concealed locations unless indicated exposed, or in equipment rooms. Locate piping to avoid ductwork.

C. Install horizontal piping as high as possible without sags or humps so that proper grades can be maintained for drainage.

D. Check all piping for interference with other trades, avoid placing water pipes over electrical equipment.

E. Where rough-in is required for equipment furnished by others, verify exact rough-in dimension with owner or equipment supplier before roughing-in.

F. Install automatic temperature control valves and other items as called for to be installed in piping and furnished by Section 23 09 00 – Building Automation System (BAS).

G. Piping up to 2" diameter shall be screwed, piping 2-1/2" diameter and over shall be welded.

H. Fiberglass Piping System: Install in accordance with the manufacturer’s current published installation procedures. All joints installed or constructed in the field shall be assembled by employees of the contractor who have been trained by the pipe manufacturer. The pipe manufacturer or their authorized representative shall train the contractor’s employees in the proper joining and assembly procedures required for the project, including hands-on participation by the contractor’s employees. Each bonder shall fabricate one pipe-to-pipe and one pipe-to-fitting joint that shall pass the minimum pressure test. Only bonders who have successfully completed the pressure test shall bond pipe and fittings.

3.04 HYDRONIC SPECIALTIES

A. Air separator shall not be supported by piping; install pipe hanger at inlet and outlet.

B. Install pressure reducing and fill valves as indicated and make cold water connection. Install fast fill by-pass line with globe valve.

C. Install manual air vents for each terminal unit coil and at other points likely to entrap air.

D. Maintain access to pressure and temperature test stations.
E. Install backflow preventers in accordance with manufacturer's recommendations. Installing Contractor shall provide testing by a certified backflow assembly tester at the time of installation as required by the Uniform Plumbing Code. Install air gap fitting and pipe to nearest floor drain.

F. Replace up to 10% of automatic flow control cartridges as required to adjust flow or pressure range during balancing. Coordinate with TAB Contractor as required.

3.05 EQUIPMENT CONNECTIONS

A. General: Connect hydronic piping system to mechanical equipment as indicated, and comply with equipment manufacturer's instructions where not otherwise indicated. Install shutoff valve and union on supply and return, drain valve on drain connection.

B. Hydronic Terminals: Install hydronic terminals with valve and union on outlet; union, shutoff valve on inlet. Install manual air vent on element in accordance with manufacturer's instructions. Locate valves and balancing cocks behind valve access doors for ease of maintenance. Where indicated, install automatic temperature control valve with unions between valve and element on supply line.

3.06 FIELD QUALITY CONTROL

A. Piping Tests: Test hydronic piping in accordance with testing requirements of Division-23 Basic Materials and Methods, Section 23 00 10 - HVAC General Provisions.

B. Fiberglass Piping System: A cyclic hydrostatic pressure test shall be conducted on the completed piping system. The piping system shall be subjected to 10 pressurization cycles from 0 psig to 1.5 times the design operating pressure. After 10 cycles, the pressure shall be held on the system for a minimum of 1 hour and the line inspected for leaks. All joints that are found to leak by observation or during testing shall be repaired by the contractor and retested.

3.07 ADJUSTING AND CLEANING

A. Cleaning, Flushing and Inspecting: Clean, flush and inspect hydronic piping systems in accordance with requirements of Division-23 Basic Materials and Methods, Section 23 00 10 - HVAC General Provisions.

END OF SECTION 23 21 13
COLLEGE COMMUNITY SCHOOL DISTRICT
PRAIRIE EARLY CHILDHOOD CENTER

SECTION 23 21 23 - HYDRONIC PUMPS

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Extent of HVAC pumps work required by this section is indicated on drawings and schedules, and by requirements of this section.

B. Types of pumps specified in this section include the following:
   1. In-line Circulators
   2. End Suction Base Mounted Pumps

C. 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 pumps. Include starters, disconnects and required electrical devices, except where specified as furnished, or factory installed, by manufacturer.

1.03 QUALITY ASSURANCE

A. UL Compliance: Design, manufacturer and install HVAC pumps in accordance with UL 778 "Motor Operated Water Pumps".

B. UL and NEMA Compliance: Provide electric motors and components which are listed and labeled by Underwriters Laboratories and comply with NEMA standards.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's pump specifications, installation and start-up instructions, and current accurate pump characteristic performance curves with selection points clearly indicated.

B. Shop Drawings: Submit manufacturer's assembly type shop drawings indicating dimensions, weight loadings, required clearances and method of assembly of components.

C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to HVAC pumps. 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.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Handle HVAC pumps and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged HVAC pumps or components; replace with new.

B. Store HVAC pumps and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris and physical damage.
PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Pumps

1. Aurora
2. Bell & Gossett ITT; Fluid Handling Div.
3. Taco, Inc.
4. Armstrong
5. Grundfos / Paco
6. Patterson Pump

B. Pump Connectors

1. Keflex
2. Metraflex
3. Twin City Hose
4. Minnesota Flexible

C. General: Provide factory tested pumps, thoroughly cleaned and painted with one coat of machinery enamel prior to shipment. Type, size and capacity of each pump is listed in pump schedule. Provide pumps of same type by same manufacturer.

2.02 IN-LINE CIRCULATORS

A. General: Provide in-line circulator pumps where indicated, and of capacities as scheduled.

B. Type: Horizontal mount, permanently lubricated, designed for 150 psi working pressure, and 225 deg. F continuous water temperature.

C. Construction: Cast iron body with suction and discharge flanges. Steel shaft mounted on permanently lubricated, sealed ball-bearings. Water-tight seal fill mechanical carbon on silicon carbide face seals.

D. Impeller: Composite construction, enclosed type, hydraulically and dynamically balanced, and keyed to shaft.

E. Motor: Non-overloading at any point on pump curve, drip-proof, permanently sealed ball bearings, resilient mounted construction, permanent split capacitor with thermal overload protection, single phase motors.

2.03 BASE MOUNTED END SUCTION PUMPS

A. General: Install Base Mounted End-Suction Pumps where indicated, and of capacities as scheduled.

B. Type: Base mounted, single stage, end suction design with a foot mounted volute to allow servicing of the impeller and bearing assembly without disturbing piping connections. Pumps shall be designed for 175 psi working pressure, and 225 deg. F continuous water temperature.

C. Construction: Class 30 cast iron body with integrally-cast pedestal support feet, suction and discharge flanges, gauge (suction and discharge), vent and drain ports. Solid steel shaft with bronze shaft-sleeve, mounted on heavy-duty grease lubricated ball bearings. Internally flushed, carbon, mechanical seals. The pump internals shall be capable of being serviced without disturbing piping connections. Provide with wear rings.
D. Impeller: Cast bronze, hydraulically and dynamically balanced, keyed to the shaft and secured by a locking stainless steel cap screw or nut.

E. Coupling: A flexible type, center drop-out design coupling shall be employed between the pump and motor. Pumps for variable speed application shall have suitable coupling design for application. Coupling shield shall be OSHA complaint and include an inspection window.

F. Motor: Motors shall have heavy-duty grease lubricated ball bearings. Motors shall be non-overloading at any point on the pump curve. Motor shall meet NEMA specifications and shall be of the size, voltage and enclosure called for on the plans. Pump and motor shall be factory aligned, and shall be realigned by Contractor after installation.

G. Base: Structural steel or fabricated steel channel with fully enclosed sides and ends, and securely welded cross members. Grouting area shall be fully opened.

H. Each pump shall be factory tested per Hydraulic Institute standards. It shall then be thoroughly cleaned and painted with at least one coat of high grade machinery enamel prior to shipment.

I. Suction Diffuser: Provide at each base mounted pump a Suction Diffuser, size to match pipe x pump inlet dimensions. Units shall consist of angle type cast iron body with steel straightening vanes and steel combination Diffuser-Orifice Cylinder with 3/16” diameter openings for pump protection. A permanent magnet shall be located within the flow stream and shall be removable for cleaning. The orifice cylinder shall be equipped with a disposable fine mesh bronze strainer which shall be removed after system start-up. Orifice cylinder shall be designed to withstand pressure differential equal to pump shutoff head and shall have a free area equal to five times cross section area of pump suction opening. Straightening vanes shall extend the full length of the orifice cylinder and shall be replaceable. Unit shall be provided with adjustable support foot to carry weight of suction piping.

2.04 PUMP CONNECTORS

A. Pump Connectors to be braided type, corrugated hose with stainless steel, Metraflex Metra-Mini Series.

B. For grooved piping systems, in addition to the pump connector indicated above, provide flexible couplings for first three (3) joints on each side of the pump.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which HVAC pumps are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable with Installer.

3.02 INSTALLATION OF PUMPS

A. General: Install HVAC pumps where indicated, in accordance with manufacturer’s published installation instructions, complying with recognized industry practices to ensure that HVAC pumps comply with requirements and serve intended purposes.

B. Access: Provide access space around HVAC pumps for service as indicated, but in no case less than that recommended by manufacturer.
C. Support:

1. Install in-line pumps, supported from piping system. See Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment for vibration isolation of piping system.

2. Support: Grout base mounted pumps to housekeeping pads with non-shrinking grout in accordance with manufacturer’s recommendations. Level pumps as required prior to grouting.

D. Controls: Install devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer for power wiring.

1. Verify that wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

E. Piping Connections: Refer to Division-23 HVAC piping sections. Provide piping, valves, accessories, gauges and supports as indicated, including the following:

1. Flexible connector in suction and discharge line of base mounted pumps.
2. Shut-off valve in suction line.
3. Check valve and shut-off valve in discharge line. For pipe sizes 2” and larger, check valve to be spring loaded silent type. At Contractor’s option, an indicating type butterfly valve may be used in lieu of balancing cock and shut-off valve.
4. Compound gauge with turn cocks connected between pump suction and discharge. For pumps with suction diffusers, provide connection at inlet to suction diffuser as well along with turn cock.

3.03 INSTALLATION OF PUMPS - ALIGNMENT

A. Provide factory-authorized service representative to perform alignment service after installation of the pumps is completed.

B. Comply with requirements in Hydronics Institute Standards for alignment of pump and motor shaft. Perform initial alignment at ambient temperature and perform subsequent alignment with pump at operating temperature. Laser alignment of the pumps shall be included.

3.04 START-UP SERVICE

A. Provide factory-authorized service representative to perform start-up service after installation of the pumps is completed.

1. Complete manufacturer's recommended start-up checks.
2. Verify piping connections are adequate and inlet strainer is clean.
3. Verify bearing lubrication and that pump is rotating in the correct direction.
4. Verify required performance parameters, including discharge pressure, noise, and vibration.
3.05 OWNER TRAINING

A. Provide factory-authorized service representative to provide training of Owner's maintenance personnel to adjust, operate, and maintain pumps. Refer to Section 01 77 19 – Contract Closeout for additional information on training requirements.

END OF SECTION 23 21 23
SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Contractor shall furnish all equipment, materials, tools, labor and supervision necessary to fabricate and install complete piping system as required by the drawings and this section.

1. Extent of refrigerant piping work is indicated on drawings and schedules, and by requirements of this section.
   a. Refrigerant suction line piping between compressors and cooling coils.
   b. Refrigerant liquid line piping between liquid receivers and cooling coils.

2. Insulation of refrigerant piping is specified in other Division-23 sections, and is included as work of this section.

3. Installation of valves for refrigerant piping system is specified in other Division-23 sections and is included as work of this section.

1.03 QUALITY ASSURANCE

A. ANSI Code Compliance: Comply with applicable provisions of ANSI B31.5, "Refrigeration Piping", and extend applicable lower pressure limits to pressures below 15 psig.


C. UMC Compliance: Fabricate and install refrigeration piping in accordance with IAMPO "Uniform Mechanical Code".

D. IMC Compliance: Fabricate and install refrigeration piping in accordance with "International Mechanical Code".

PART 2 - PRODUCTS

2.01 BASIC MATERIALS AND PRODUCTS

A. General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide materials and products complying with ANSI B31.5 "Code for Refrigeration Piping" where applicable, base pressure rating on refrigeration piping system's maximum design pressures. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in refrigeration piping systems. Where more than one type of materials or products are indicated, selection is Installer's option.

B. Valves: Refer to Section 23 05 23 - General Duty Valves for HVAC Piping.

C. Piping Specialties: Refer to Section - 23 05 00 - Common Work Results for HVAC.
D. Supports, Anchors and Seals: Refer to Section 23 05 29 - Hangers and Supports for HVAC Piping.

2.02 PIPE:

<table>
<thead>
<tr>
<th>Material</th>
<th>Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Copper refrigeration tube, soft temper. Type L-ACR.</td>
<td>Refrigerant lines for systems less than 5 tons.</td>
</tr>
<tr>
<td>B. Copper refrigeration tube, hard temper. Type L-ACR.</td>
<td>Refrigerant lines for systems over 5 tons.</td>
</tr>
</tbody>
</table>

2.03 FITTINGS:

A. Copper refrigerant tubes:

1. 3/4” and Smaller: Cast copper-alloy for flared copper tubes.
2. 7/8” through 4 1/8”: Wrought-copper, solder joints.

2.04 JOINTS

A. Copper refrigerant tube:

1. 3/4” and Smaller: Flared.
2. 7/8” through 4 1/8”: Soldered, silver-lead solder, ANSI/ASTM B 32, Grade 96 TS.

PART 3 - EXECUTION

3.01 INSPECTION

A. General: Examine areas and conditions under which refrigerant piping systems materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.02 INSTALLATION OF BASIC MATERIALS AND PRODUCTS

A. General: Install basic materials and products as required per manufacturer’s recommendations, ANSI B31.5 Code for Refrigerant Piping and as required to meet the intent of the documents.

B. Refrigerant Piping

1. Install pipe for all refrigerant systems as indicated on drawings, as called for in other sections, and as specified herein.

2. Arrange and install piping approximately as indicated; straight, plumb, and as direct as possible; form right angles on parallel lines with building walls. Keep pipes close to walls and avoid interference with other refrigerant items. Locate groups of pipes parallel to each other; space at a distance to permit applying full insulation and to permit access for servicing valves. Most piping to be run in concealed locations unless indicated exposed, or in equipment rooms. Locate piping to avoid ductwork.

3. Install horizontal piping as high as possible without sags or humps so that proper grades can be maintained for drainage. Pitch piping in direction of oil return to compressor.
4. Check all piping for interference with other trades, avoid placing water pipes over electrical equipment.

5. Where rough-in is required for equipment furnished by others, verify exact rough-in dimension with owner or equipment supplier before roughing-in.

6. Where refrigeration piping is buried, encase piping and insulation loosely in schedule 40 PVC and ventilate PVC pipe to allow vapor line to see outside air temperature. Ensure PVC pipe is free draining to prevent water buildup. Provide a riser trap and slope refrigeration line to trap. Where buried lengths exceed 25’, provide a 90 minute timer wired parallel with thermostat control to operate unit every 90 minutes to maintain safe slugging levels.

C. Valves

1. Refer to Section 23 05 23 - General Duty Valves for HVAC Piping.

2. Locate valves for easy access and operation. Do not locate valves with stems below horizontal.

D. Piping Specialties: Refer to Section 23 05 00 - Common Work Results for HVAC.

E. Supports, Anchors and Seals: Refer to Section 23 05 29 - Hangers and Supports for HVAC Piping.

F. Install specialties and accessories as indicated on drawings and in accordance with manufacturer’s recommendations and applicable codes and standards.

G. Equipment Connections

1. General: Connect refrigerant piping system to refrigerant equipment as indicated, and comply with equipment manufacturer's instructions where not otherwise indicated.

H. Field Quality Control

1. Refrigerant Piping Leak Test: Prior to initial operation, test refrigerant piping with electronic leak detector. System must be entirely leak-free.

2. Repair or replace refrigerant piping as required to eliminate leaks, and retest as specified to demonstrate compliance.

END OF SECTION 23 23 00
SECTION 23 31 13 - METAL DUCTS

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this Section.

1.02 DESCRIPTION OF WORK

A. Provide material, equipment, labor and supervision necessary to fabricate and erect ductwork as required by the drawings and this section.

B. Low velocity ductwork shall apply to the following:

1. Supply: Downstream of terminal units.
2. Return: Upstream of terminal units.
3. Exhaust: Upstream of terminal units.
4. Transfer & Combustion: Less than 1” static pressure.
5. Outdoor & Relief: Upstream/Downstream of unit.

1.03 DEFINITIONS

A. Conditioned Space: An area inside the building which is heated and/or cooled.

B. Tempered Space: an area inside the building which is not directly heated or cooled, but is adjacent to a heated or cooled space with no insulation separating the two spaces (e.g., ceiling plenums).

C. Untempered Space: an area inside the building which is not conditioned and is not tempered (e.g., attic spaces).

D. Exterior: An area outside the building (e.g., roof mounted items).

1.04 QUALITY ASSURANCE

A. Duct and plenum construction, metal gauges, reinforcing, methods of supporting and hanging and other sheet metal work as called for shall be in accordance with the following standards:


B. Unless noted otherwise, all ductwork shall be provided with pressure class and leakage class as indicated and scheduled on the plans. If pressure or seal class is not indicated, ductwork shall be provided to meet the pressure class based on the scheduled capacity of the equipment it is served by or connected to and with seal class A.

C. NFPA Compliance: All liner and covering materials shall have maximum UL Flame Spread Index of 25, and maximum Smoke Developed Index of 50, and shall meet all requirements of NFPA-90A.
1.05 SUBMITTALS

A. Shop Drawings:
   1. Submit 1/4 scale shop fabrication shop drawings.
      a. Shop drawings shall include locations of all control devices, including dampers, airflow measuring stations, sensors, etc. Coordinate locations with the BAS Contractor prior to submitting shop drawings. Shop drawings shall include the BAS Contractor's submittal review stamp prior to submitting to the Design Professional for review.
   2. Submit shop drawings of elbows and fittings showing static pressure loss charted for air quantities involved in each.

B. Two copies of duct leak testing results.

C. Submit weld sample, welding information, and welders’ certification for weld stainless steel ductwork. Submittal to include the following information:
   1. Welder name(s):
   2. Certification:
   3. Metal type and gauge:
   4. Joint preparation:
   5. Welding process:
   6. Equipment utilized:
   7. Filler specifications:
   8. Shield gas:

D. Product Data: Submit manufacturer's specifications and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, thickness, and furnished accessories for each mechanical system requiring insulation. Submit product data for each accessory/component for ducts/fittings including, but not limited to turning vanes, tie rods, sealants and balancing dampers.

E. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data in maintenance manual.

F. Certifications: Submit certifications or other data as necessary to show compliance with these specifications and governing regulations. Include proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.

G. Submit product data for kitchen exhaust ductwork.

1.06 REGULATORY REQUIREMENTS


1.07 DELIVERY, STORAGE, AND HANDLING

A. Protect shop-fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling.
   1. Stored materials subject to rejection due to damage.
B. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard ratings of products.

C. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged insulation; remove from project site.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. All sheet metal work shall be constructed of prime quality re-squared tight coat galvanized steel, except where other type material is specified. Manufacturer's name and U.S. gauge number shall appear on each sheet.

B. Duct Lining Materials
   1. Certain-Teed
   2. Owens Corning Fiberglass
   3. Johns-Manville
   4. PPG
   5. Knauf

C. Flexible Ductwork
   1. Flexmaster: Type 3
   2. Genflex: IHPL (1-1/2" thick insulation)

D. Double Wall Spiral Ductwork
   1. Semco Incorporated
   2. Steelcraft Corp.
   3. United Sheet Metal Division, United McGill Corp.
   4. Norlock
   5. Eastern Sheet Metal

2.02 LOW VELOCITY DUCTWORK

A. General: Provide factory-fabricated or shop fabricated duct and fittings.

B. Materials:
   2. Aluminum sheet complying with ASTM B 209 Alloy 3003, H14 temper with mill finish. Where ductwork is exposed and not designated to be painted, provide one-side bright finish.

C. Gauge: Comply with code requirements for minimum gauge thickness for various sizes.

D. Fittings:
   1. Construct branches, bends, and elbows with centerline radius of not less than duct 1.0 times the width (diameter), where space conditions will not permit this radius or where indicated on drawings, square elbows with air turns shall be used.
2. Slopes for transitions or other changes in dimension shall be minimum 1:3.

3. Longitudinal seams shall be Pittsburgh Lock or snaplock equal per SMACNA. Lateral seams shall be slip drive or standing. Slip seams and sheet metal screws not permitted.

2.03 DOUBLE-WALL, SPIRAL ROUND/oval, INSULATED

A. General: Provide factory fabricated double-wall, spiral round/oval, insulated ductwork and fittings of dimensions as indicated on the drawings.


C. Construction:

1. Outer Casing: Round spiral lock seam or flat oval construction.
2. Inner duct: Minimum 0.028 inch perforated galvanized steel with 23% open area perforations.
3. Insulation: 1 inch thick fiberglass, thermal conductivity of 0.27 Btu/h/sq. ft./F/inch.

D. Fittings: Equal to duct construction.

1. Construct branches, bends, and elbows with centerline radius of not less than 1.0 times the duct width (diameter). Where space conditions will not permit this radius or where indicated on the drawings, square elbows with air turns shall be used.
2. Slopes for transitions or other changes in dimension shall not exceed 15 deg, unless noted on the drawings.

E. Joints: All field joints shall be made with a 2” slip-fit or slip coupling. All flanges shall be factory installed.

F. All branch connections in exposed areas shall be made with taps mounted on spiral duct. Taps on rolled duct bodies will not be allowed.

2.04 STAINLESS STEEL EXHAUST DUCTS – LOW VELOCITY

A. General: Fabricate all exhaust ducts and supports of ASTM A167, Type 304L, 16 gauge, stainless steel. Welded construction to be in accordance with ANSI/AWS standard D9.1-90.

2.05 STAINLESS STEEL EXHAUST DUCTS – HIGH VELOCITY

A. General: Fabricate all exhaust ducts and supports of ASTM A167, Type 304L stainless steel, minimum 16 gauge construction.

B. Construct branches, bends, and elbows with center line radius if not less than 1 1/2 times duct width (diameter).

C. Slopes for transitions shall be minimum 1:3.

D. All joints, constructions and fittings shall be welded in accordance with ANSI/AWS Standard D 9.1 - 90.

2.06 PLENUMS

A. Plenums shall be fabricated of same material as duct connecting to plenum; shall be two metal gauges heavier than gauge of largest duct connecting to plenum.
2.07 KITCHEN EXHAUST DUCTS

A. General:
   1. Fabricate kitchen exhaust ducts and supports, used for smoke and vapor removal from cooking equipment, of 16 gauge minimum stainless steel where concealed, and of 18 gauge minimum stainless steel where exposed.
   2. For duct construction, comply with SMACNA "Low Pressure Duct Standards" – most recent Edition, and ANSI/NFPA 96 "Vapor Removal from Commercial Cooking Equipment".

B. All duct seams, joints, penetrations and duct to hood connections shall be made with a liquid tight continuous external weld or as required by NFPA 96.

2.08 LAUNDRY VENT DUCTS

A. General:
   1. Fabricate laundry vent ducts and supports, used for venting of commercial or residential laundry dryers, of 22 gauge minimum aluminum. The male end of the duct at overlapped duct joints shall extend in the direction of airflow. No sheetmetal screws or fasteners shall penetrate the duct wall.
   2. Each vertical laundry vent riser shall be provided with a means of cleanout at the base.
   3. Duct shall terminate outside the building as shown on drawings. A backdraft damper shall be installed at the termination. No bird or insect screens shall be installed at the termination point.

2.09 DUCT SEALING – LOW VELOCITY

A. All joints in low velocity duct work shall be sealed with Foster 32-14 or DuctMate ProSeal. Apply and install joint sealer per manufacturer's recommendations. In general, apply to male end of coupling and/or interior of female fitting. After connection, brush sealant over the assembled joint and screws with a 2" to 3" wide band. Sealant shall be allowed to set for 48 hours before any air pressure is put on system. All tie bars, bolts and rivets shall be sealed with the specified sealant. Sealant as manufactured by Minnesota Mining No. 800 or United Sheet Metal will be considered equal.

B. Alternate Sealing System:
   1. Transverse duct joints may be made with the Ductmate System or an approved equal.
   2. The installation of the Ductmate System shall be in accordance with the manufacturer's printed instruction and installation manuals.
   3. The standard Ductmate System joint is the equivalent of a SMACNA "J" connection. The Ductmate-JR System joint is the equivalent of a SMACNA "E" connection. Construction of the duct, such as gauge, reinforcing, etc. shall be as indicated in the addendum to the SMACNA manuals as provided by the manufacturer and as tested by Pittsburgh Testing Laboratory.

C. Duct Sealing Requirements: SMACNA Seal Class A.
2.10 DUCT LINER

A. Lining materials shall be Type 'A' Duct Liner, Certain-Teed Toughgard or equivalent, one and one half (1 1/2) pounds per cubic foot density or equal.

B. Unless noted otherwise, all ductwork and accessories shall be either lined or covered as scheduled on plans. If type or thickness is not indicated, it shall be 1-1/2” covering.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Assemble and install ductwork in accordance with recognized industry practices which will achieve airtight and quiet systems, capable of performing each indicated service.

1. Install each run with minimum joints.
2. Align ductwork accurately at connections and with internal surfaces smooth.
3. Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts true-to-shape and prevent buckling and vibration.

B. Ducts shall be installed following essentially lines indicated on drawings, install offsets, angles and transitions as may be required to avoid interferences with other work. Maintain full capacity of ducts at offsets, angles and transitions except where drawings indicate use of reducing or increasing transitions.

1. General: Each duct section shall be rigidly supported from structure. Attach hangers to structure with expansion plugs, concrete inserts, beam clamps or other approved means. Rubber in-shear isolators shall be installed in hangers for all ducts in equipment rooms, to prevent vibration transmission to the structure.

C. Install hangers and supports in accordance with SMACNA Standards general locations:

1. Install hangers close to transverse joints of main ducts and branches, clinch collar branch connections and the first branch elbows after nested splits.
2. Locate hangers of duct penetrating walls or partitions as though the walls will contribute no support to the duct.
3. Install hangers in pairs on exact opposite sides of duct.
4. Maintain hanger spacing intervals less than, equal to, but not greater than the specified maximums.
5. Install hangers at the midpoint of small and medium size horizontal vaned square elbows. On wide vaned square elbows, install additional hangers at maximum allowable intervals or less measured along the heel lines of the elbows.
6. Provide a set of hangers at the midpoint of small and medium size horizontal radius elbows. Install one or more supplementary hangers, as necessary, along the inside and outside arcs of large radius elbows of any angle whenever the lengths of these arcs exceed the maximum hanger spacing length for that particular size duct.
7. Provide at least one set of hangers for short duct branches 3 feet or less in length.
8. Provide each duct riser with a minimum of two supports completely spanning the shaft opening at each floor. One pair of supports may be used to support more than one duct riser, provided that the strength of the supports is increased appropriately and proper additional supplementary steel is used at the extra risers.

9. Support duct risers, located between floors that are more than 15 feet high, at each floor and halfway points between floors. The distance between intermediate supports on very high floors should not exceed 12 feet. Intermediate hangers may be supported from an adjacent wall or hung by rods from supports on the floor above.

10. Provide one or more sets of hangers for equipment in duct runs such as heating coils, heat pumps, etc., as recommended by their manufacturers.

D. Locate duct hangers approximately:

1. 2 to 24 inches from flexible connections of fans.

2. 2 to 24 inches from the outlets or flexible connects of VAV control units or mixing boxes.

3. 12 to 36 inches from the main duct to the first hanger of long branch ducts.

4. 2 to 12 inches from the ends of all branch ducts and linear diffuser plenums.

5. 2 to 24 inches from fire damper breakaway joints.

6. 0 inches to half the duct width plus 2 inches from the vertical centerline of the lower elbow of short vertical offsets made with vaned square elbows. The width refers to the dimension of the elbow in the plane of the turn.

7. 0 inches to half the duct width plus 2 inches from the vertical centerline of the bottom and top elbows of vaned square elbow offsets over 8 feet high.

8. One-eighth of the arc in from the ends of bottom and top radius elbows of vertical offsets longer than 8 feet. Short vertical offsets require hangers at the bottom elbow. Likewise, sloping offsets need at least one set of hangers at their lower radius elbow.

9. 6 to 12 inches from transverse joints of ducts whose lengths are the same as specified hanger intervals.

10. 6 to 12 inches from one side of walls or partitions penetrated by ducts.

E. Maximum permitted hanger spacing:

1. Ducts with areas up to 4 square feet may have their hangers spaced up to 8 feet apart.

2. Ducts with areas 4.1 to 10 square feet may have their hangers spaced not more than 6 feet apart.

3. Ducts with areas over 10 square feet may have their hangers located up to 4 feet apart.

F. Provide and install locking manual volume dampers in all duct systems as required for controlling air volumes to trunk ducts, branch ducts, outlets and inlets. Provide and install additional volume dampers as required by Testing and Balancing Contractor for balancing of system.
G. All connections shall be sealed, including but not limited to branch connections, spin-ins, taps, access doors, access panels and connections to equipment. Openings for rotating shafts shall be sealed with bushings or other devices that seal off air leakage.

H. Duct sizes shown on drawings are net inside dimensions and sheet metal size shall be increased to allow for duct linings.

I. Install as indicated on the drawings all duct mounted equipment as specified in other sections.

J. Install eccentric reducers with tops of both duct sizes flush to maintain maximum ceiling space below ducts.

K. Openings:
   1. Provide in ductwork to accommodate access doors, temperature control components and fire dampers.
   2. Install access panels for inspection and servicing of all duct mounted equipment including, but not limited to: reheat coils, sound attenuators, motorized dampers, airflow measuring stations, smoke and fire dampers.
   3. Provide pitot tube openings for testing of systems, complete with metal cap, with spring device or screw to ensure against air leakage.
   4. Where openings are provided in insulated ductwork, install insulation materials inside metal collar.
   5. For kitchen exhaust hood grease ductwork, provide cleanouts as required by code. In general, for horizontal ducts cleanouts shall be spaced not more than 20 feet apart and be located not more than 10 feet from changes in direction that are greater than 45 degrees. For vertical ducts, provide a cleanout on each floor level. Provide a cleanout at the inlet of sidewall and roof mounted exhaust fans and at inlet and outlet of in-line fans.

L. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

M. Connections:
   1. Connect duct to equipment with flexible fabric, sheet metal clips, screws and washers.
   2. At each point where ducts pass through partitions, provide sleeve with space between duct and sleeve packed with insulation and sealed.

N. Where ducts pass through fire-rated walls, partitions, floors, and ceilings, seal openings in accordance with Specification Section 23 0500 - Common Work Results for HVAC.

3.02 DUCT LINER APPLICATION

A. Apply duct liner with coated or surface designed to be exposed facing the air stream and adhered with 100% coverage of fire retardant adhesive. When width exceeds 12" or height exceeds 24", additionally secure liner with mechanical fasteners spaced 12" maximum centers. Fasteners shall start within 3" of leading edge of traverse joints. Coat all exposed joints and edges of traverse joints with a fire retardant adhesive.
B. Duct sizes shown on drawings are net inside dimensions and sheet metal size shall be increased to allow for duct lining.

3.03 **ADJUSTING AND CLEANING**

A. Cleaning:

1. Clean ductwork internally, as it is installed, of dust and debris.

2. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or where ductwork is to be painted.

B. Temporary Closure:

1. At ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation or that are on-site but not yet installed, provide temporary closure of polyethylene film or other covering until time connections are to be completed.

3.04 **DUCTWORK APPLICATION SCHEDULE – LOW VELOCITY**

<table>
<thead>
<tr>
<th>AIR SYSTEM</th>
<th>MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>HVAC Supply, Return General Exhaust</td>
<td>Steel, Galvanized, Aluminum</td>
</tr>
<tr>
<td>Laundry Vent</td>
<td>Aluminum</td>
</tr>
<tr>
<td>Kitchen Exhaust, Fume Hood Exhaust</td>
<td>Stainless Steel, Welded</td>
</tr>
</tbody>
</table>

**END OF SECTION 23 31 13**
SECTION 23 31 16 - NONMETAL DUCTS

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Extent of non-metal ductwork is indicated on the drawings and by requirements of this section.

B. Provide material, equipment, labor and supervision necessary to fabricate and erect ductwork as required by the drawings and this section.

1.03 QUALITY ASSURANCE

A. Fiberglass Reinforced Plastic and High-Density Polyethylene Ductwork: Duct construction, gauges, reinforcing, methods of supporting and hanging and other sheet metal work as called for shall be in accordance with the following standards:


B. Non-fibrous, Closed Cell, Outdoor Ductwork: Duct construction, thickness, reinforcing, methods of supporting and hanging and other sheet metal work as called for shall be in accordance with the manufacturer's installation instructions.

   1. Ductwork shall conform to the following pressure classifications.

      Supply & Ventilation - Rectangular ..... 6" positive
      Return - Rectangular.......................... 6" negative

   2. Duct System shall be rated to SMACNA leakage Class 1 or better.

C. Fabric Air Dispersion Ductwork: Duct shall be in accordance with the following standards:

   1. Product must be classified by Underwriter’s Laboratories in accordance with the 25/50 flame spread/smoke developed requirements of NFPA 90-A.

   2. All product sections must be labeled with the logo and classification marking of Underwriter’s Laboratories.

   3. Manufacturer must have documented design support information including duct sizing, vent and orifice location, vent and orifice sizing, length, and suspension. Parameters for design, including maximum air temperature, velocity, pressure, and fabric permeability, shall be considered and documented.

1.04 SUBMITTALS

A. Shop Drawings:

   1. Submit 1/4 scale shop fabrication shop drawings.

   2. Submit shop drawings of elbows and fittings showing static pressure loss charted for air quantities involved in each.
3. For fabric air dispersion ductwork, provide detailed drawings showing suspension system and attachment points and ductwork perforation patterns. Provide throw data for each run of fabric ductwork showing compliance with ASHRAE 55 standard for velocity at the occupied zone.

B. Submit manufacturer’s data on materials, fittings and joint construction, and installation for nonmetal ductwork. Shall include UL file number under which product is classified by Underwriter’s Laboratories where applicable.

C. Two copies of duct leak testing results (where applicable).

D. Coordinate submittal with the requirements of Section 23 31 13 - Metal Ducts.

1.05 REGULATORY REQUIREMENTS

B. Underwriter’s Laboratories, UL 181: Factory-Made Duct Materials and Air Duct Connections.

1.06 DELIVERY, STORAGE AND HANDLING

A. Protect ductwork and accessories and purchased products from damage during shipping, storage and handling.

B. Store products inside and protect from weather.

1. Stored materials subject to rejection due to damage.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Non-fibrous, Closed Cell, Outdoor Ductwork

1. Thermaduct, LLC
2. AQC Duct

B. Fabric Air Dispersion Ductwork

1. DuctSox Corporation

2.02 NON-FIBROUS, CLOSED CELL, OUTDOOR DUCTWORK

A. The panel shall be manufactured of CFC-free closed cell rigid thermoset resin thermally bonded on both sides to a factory applied .001” (25 micron) aluminum foil facing reinforced with a fiberglass scrim. An added UV stable, 39 mil high impact resistant titanium infused vinyl is factory bonded to the outer surfaces to provide a zero permeability water tight barrier.

B. The thermal conductivity shall be no greater than 0.13BTU • in/Hr • ft2•°F.

C. The density of the foam shall not be less than 3.5 pcf with a minimum compressive strength of 28 psi (.2 MPa).
D. The standard panel is 1-1/4" thick. The insulative value shall be R-8.1.

1. Maximum Temperature: Continuous rating of 185 degrees F inside ducts or ambient temperature surrounding ducts.

2. Permeability: 0.00 perms maximum when tested according to ASTM E 96/E 96M, Procedure A.

3. Antimicrobial Agent: Additive for antimicrobial shall not used but product must pass UL bacteria growth testing.

4. Noise-Reduction Coefficient: 0.05 minimum when tested according to ASTM C 423, Mounting A.

5. Required Markings: All interior duct liner shall bear UL label and other markings required by UL 181 on each full sheet of duct panel; UL ratings for internal closure materials.

E. Closure Materials:

1. V-Groove Adhesive: Silicone (interior only).

2. UV stable 39 mil high impact resistant titanium infused vinyl (exterior).
   a. Factory manufactured seamless corners for zero perms.
   b. Cohesive bonded over-lap at corner seam covers for zero perms.
   c. Water resistant titanium infused welded vinyl seams.
   d. Mold and mildew resistant.

3. Polymeric Sealing System:
   a. Structural Membrane: Aluminum scrim with woven glass fiber with UV stable vinyl clad applied.
   b. Minimum Seam Cover Width: 2 7/8" inches.
   c. Sealant: Low VOC.
   e. Water resistant.
   f. Mold and mildew resistant.

4. Duct Connectors:
   a. Factory manufactured cohesive bonded strips (low pressure only).
   b. Factory manufactured all aluminum grip flange.
   c. Factory manufactured galvanized 4-bolt flange.

5. Outdoor Cladding:
   a. Outdoor Installations: Duct segments shall incorporate UV stable 39 mil high impact resistant titanium infused vinyl which is introduced during the manufacturing process.

6. Flange Coverings:
   a. Flanges are field sealed airtight before flange covers are installed. Flange covering consists of foam tape insulation with molded 39 mil covers.
2.03 FABRIC AIR DISPERSION DUCTWORK

A. Permeable Air Dispersion Ductwork

1. Fabric: Air diffusers shall be constructed of woven fire retardant fabric complying with the following physical characteristics:
   a. Fabric Construction: 100% Flame Retardant.
   b. Weight: 6.2 oz./yd² per ASTM D3776.
   c. Color: To be selected by Architect from manufacturer’s standard offerings, provide color sample chart with submittal.
   d. Fabric Porosity: 2 (+2/-1) cfm/ft² per ASTM D737, Frazier.
   e. Temperature Range: 0 degrees F to 180 degrees F.
   f. Fire Retardancy: Classified by Underwriters Laboratories in accordance with the requirements of NFPA 90A and AC-167.

2. System Fabrication Requirements:
   a. Air dispersion accomplished by linear vent and permeable fabric.
   b. Size of and location of linear vents to be specified and approved by manufacturer.
   c. Inlet connection to metal duct via fabric draw band with anchor plates as supplied by manufacturer. Anchor patches to be secured to metal duct via zip screw faster supplied by the Contractor.
   d. Inlet connection to include zipper for easy removal/maintenance.
   e. Lengths to include required zippers as specified by manufacturer.
   f. System to include Adjustable Flow Devices to balance turbulence, airflow and distribution as needed. Flow restriction device shall include ability to adjust the airflow resistance from 0.06 – 0.6 in w.g. static pressure.
   g. Fabric system shall include connectors to accommodate suspension system listed below.
   h. Any deviation from a straight run shall be made using a gored elbow or an efficiency tee. Normal 90 degree elbows are 5 gores and the radius of the elbow 1.5 times the diameter of the fabric duct.

3. Design Parameters
   a. Textile air diffusers shall be designed from 0.25” w.g. minimum to 3.0” maximum, with 0.5” as the standard.
   b. Textile air diffusers shall be limited to design temperatures between 0 degrees F and 180 degrees F.
   c. Design CFM, static pressure and diffuser length shall be designed or approved by the manufacturer.
   d. Fabric diffusers shall not be used in concealed locations.
   e. Fabric diffusers shall be used only for positive pressure air distribution components of the mechanical ventilation system.

B. Non-Permeable Air Dispersion Ductwork

1. Air diffusers shall be constructed of a coated woven fire retardant fabric complying with the following physical characteristics:
   a. Fabric Construction: 100% Polyester
   b. Coating: Non-air permeable coating
   c. Weight: 5.5 oz./yd² per ASTM D3776
g. Color: To be selected by Architect from manufacturer’s standard offerings, provide color sample chart with submittal.

d. Air Permeability: 0 cfm/ft² per ASTM D737, Frazier

e. Temperature Range: 0 degrees F to 180 degrees F

f. Fire Retardancy: Classified by Underwriters Laboratories in accordance with the flame spread/smoke developed requirements of NFPA 90-A and UL 2518.

2. Systems Fabrication Requirements

a. Dispersion orifice sizing, up to 5 inch diameter (design dependent).

b. Size, quantity, and location of orifices to be specified and approved by manufacturer.

c. Inlet connection to metal duct via fabric draw band with anchor patches as supplied by manufacturer. Anchor patches to be secured to metal duct via zip screw fastener – supplied by contractor.

d. Lengths to include required zippers as specified by manufacturer.

e. System to include Adjustable Flow Devices to balance turbulence, airflow and distribution as needed. Flow restriction device shall include ability to adjust the airflow resistance from 0.06 – 0.60 in w.g. static pressure.

f. Fabric system shall include connectors to accommodate suspension system listed below.

g. Any deviation from a straight run shall be made using a gored elbow or an efficiency tee. Normal 90 degree elbows are 5 gores and the radius of the elbow is 1.5 times the diameter of the duct.

3. Design Parameters

a. Textile air diffusers shall be designed from 0.25" water gage minimum to 3.1" maximum, with 0.5" as the standard.

b. Textile air diffusers shall be limited to design temperatures between 0 degrees F and 180 degrees F (-17.8 degrees C and 82 degrees C).

c. Design CFM, static pressure and diffuser length shall be designed or approved by the manufacturer.

d. Do not use fabric diffusers in concealed locations.

e. Use fabric diffusers only for positive pressure air distribution components of the mechanical ventilation system.

C. Suspension Hardware

1. Tension Cable: System shall be installed using a tension cable system including a single row run of cable for ducts less than 32” in diameter or two row run of cable for ducts 32” and larger. Single row shall be located 1-1/2” above top-dead-center. Double row shall be located 1-1/2” above the 10 and 2 o’clock locations. Hardware to include stainless steel cable, eye bolts, thimbles, cable clamps, and turnbuckle(s) as required. System attachment shall be made using Glides spaced 24 inches or less.

2. 3x1 Suspension (for 10” to 48” diameters): System shall include a 3 row connection to fabric system at 10, 12, and 2 o’clock locations. The powder-coated aluminum hangers are secured and connected to a single row tension cable every 3’ and connect to the fabric system at the 10 and 2 o’clock locations with detachable D-Clamps. The fabric system will also have intermediate Glides located at 12 o’clock and between the hangers to attach directly to the single tension cable system located 3” above top-dead-center location of the fabric system. Tension cable hardware includes stainless steel cable, eye bolts, thimbles, cable clamps, and turnbuckles as required.

3. Internal Hoop with Cable: System shall consist of an internal 360 degree hoop system, spaced 5’ on centers. System shall be installed with a 1 row Cable located 1.5” above top center. Hardware to include stainless steel cable, eye bolts, thimbles, cable clamps, and turnbuckle(s) as required. System attachment shall be made using Glides spaced 12 inches.
PART 3 - EXECUTION

3.01 FABRICATION AND INSTALLATION – NON-FIBROUS, CLOSED CELL, OUTDOOR DUCTWORK

A. Fabrication:

1. Fabricated 90-degree mitered elbows to include turning vanes.
2. Designed and fabricated duct segments and fittings will be in accordance with “SMACNA Duct Construction Standards” latest edition.
3. Both positive and negative ductwork and fittings shall be constructed to incorporate a UL Listed as a Class 1 air duct to Standard for Safety UL 181 liner with an exterior clad for permanent protection against water intrusion.
4. Duct shall be constructed to exceed requirements for snow and wind loads.

B. Ductwork shall be installed in accordance with Section 23 31 13 – Metal Ducts.

C. Support ductwork in accordance with manufacturer’s installation requirements. Support for straight runs shall be at minimum on 13’ centers. Support ductwork at all changes of direction, branch duct connections, tees, and duct accessories.

3.02 ADJUSTING AND CLEANING – FABRIC AIR DISPERSION DUCTWORK

A. Clean air handling unit ductwork prior to fabric air dispersion system unit-by-unit as it is installed. Clean external surfaces of foreign substance which may cause corrosive deterioration of facing.

B. Temporary Closure: At ends of ducts which are not connected to equipment or distribution devices at time of ductwork installation, cover with polyethylene film or other covering which will keep the system clean until installation is complete.

C. If fabric ductwork systems become soiled during installation, they shall be removed and cleaned following the manufacturers standard terms of laundry.

3.03 DUCT SEALING

A. Duct Sealing Requirements: SMACNA Seal Class A.

END OF SECTION 23 31 16
SECTION 23 33 00 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this Section.

1.02 DESCRIPTION OF WORK

A. Extent of duct accessories is indicated on drawings and by the requirements of this section.

B. Types of duct accessories required for project include the following:

1. Fire and Smoke Dampers
2. Sound Attenuators
3. Louvers
4. Volume Dampers/Regulators
5. Flexible Ducts
6. Access Doors
7. Control Dampers

1.03 QUALITY ASSURANCE

A. SMACNA Compliance: Comply with applicable portions of Sheet Metal and Air Conditioning Contractor's National Association (SMACNA) "Fire Damper and Heat Stop Guide".


C. UL Compliance: Construct, test, and label fire dampers in accordance with Underwriters Laboratories (UL) Standard 555 "Fire Dampers and Ceiling Dampers".


1.04 SUBMITTALS

A. Product Data: Submit manufacturer's specifications for each type of duct accessory, including dimensions, capacities, and materials of construction; and installation instructions.

B. Shop Drawings: Submit assembly-type shop drawings for each type of duct accessory showing interfacing requirements with ductwork, and method of fastening or support.

C. Maintenance Data: Submit manufacturer's maintenance data including parts lists for each type of duct accessory; include this data in Maintenance Manual.
PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide products manufactured by one of the following:

1. Flexible Ductwork
   a. Semco
   b. Wiremold
   c. Thermaflex
   d. Valuflex

2. Louvers
   a. American Warming & Ventilating
   b. Pottorff
   c. Greenheck
   d. Ruskin
   e. Louvers & Dampers

3. Hinged Walk-In Access Doors
   a. Ruskin
   b. United Enertech

2.02 LOUVERS

A. Galvanized Louvers

1. Furnish and install galvanized steel fabricated louvers as scheduled on the drawings.

2. Frames and blades shall be constructed of 16 gauge galvanized steel. Blades shall be 45 deg. drainable type. Jambs shall be constructed with integral downspouts for carrying water from the blades to the louver sill. Screens shall be provided on the interior of the louver and shall consist of 1/2“ mesh .041“ diameter galvanized steel wire mounted in an extruded aluminum frame. Screens shall be removable from the louver for cleaning. Louvers shall have all weld points touched up with a zinc rich paint. Louvers shall be primed for field painting by others.

3. Louvers shall pass 1025 FPM free area velocity with less than .17“ wg pressure drop and shall carry less than .01 ounces of water per square foot during a 15 minute period when tested in accordance with AMCA Standard 500. Test criteria shall be based on a 48“ square sample. Louvers shall bear the AMCA Certified Ratings Seal for both Air Performance and Water Penetration.

B. Extruded Aluminum Louvers

1. Furnish and install extruded aluminum louvers as scheduled on the drawings.

2. Frames and blades shall be .081“ thick 6063-T5 alloy extruded aluminum. Blades shall be drainable type. Jambs shall be constructed with integral downspouts for carrying water from the blades to the louver sill. Screens shall be provided on the interior of the louver and shall consist of 1/2“ mesh .063“ diameter aluminum wire mounted in an extruded aluminum frame. Screens shall be removable from the louver for cleaning. Louvers shall have a Kynar color finish in color as selected by Design Professional.
3. Louvers shall have performance as scheduled and carry less than .01 ounces of water per square foot during a 15 minute period when tested in accordance with AMCA Standard 500. Test criteria shall be based on a 48” square sample. Louvers shall bear the AMCA Certified Ratings Seal for both Air Performance and Water Penetration.

2.03 HINGED WALK-IN ACCESS DOORS

A. Hinged Walk-in Access Doors

1. Walk-In Access Doors shall be constructed of same material as ductwork/plenum they are installed in, 24 gauge minimum with double wall construction and 2” thick rigid insulation and 10”x10” (minimum) double pane viewing window. Provide sheet metal frame with air tight gasket, hinges, latches and pull handle. Refer to plans for door size and hinge location. Ruskin GPAD Sound Control or equal.

2.04 MISCELLANEOUS

A. Manual Volume Dampers: Fabricated of same material as ducts, two metal gauges heavier than duct and hammered 1” all around, mounted on 3/8” square rod with saw slot position indicator.

1. Provide end bearings with gasket - Young Regulator Co. Model 666-FD or equal by Elgin.

B. Manual Volume Damper Regulators:

1. Accessible areas: Provide locking position regulator with gasket and handle - Young Regulator Co. Model 403-FD or equal by Elgin.

2. Inaccessible areas: Provide concealed manual volume damper regulators with cover plate and gear assembly - Young Regulator Co. Model 315 or equal by Elgin.

C. Air Turns: Elgin "Air-Tite" or equal shop fabricated.

D. Flexible Duct Connection: 30 ounce woven glass fiber, double neoprene coated, fire retardant, waterproof and air tight, suitable for temperatures to 250 deg. F, UL approved. Ventfabric, Inc. "Ventglass".

E. Access Panels: Shall be of same material as ducts in which they are installed, fabricated of two thicknesses of not less than 24 gauge, with 1” thick rigid glass fiber filler. Provide sheet metal frame, air tight gasket and two Young Regulator Company No. 1330 latches, or equal by Elgin.

2.05 FLEXIBLE DUCT

A. Flexible duct shall be factory pre-insulated, consisting of vinyl coated spring steel wire helix bonded to vinyl coated fiberglass mesh screen, having one (1) inch nominal fiberglass insulation and vinyl impregnated closely woven fiberglass vapor barrier. Basis of Design: Semco, Type A1.

B. Composite assembly shall meet Class I requirements of NFPA-90A and shall be UL listed for flame spread rating of not more than 25 and smoke developed rating of not more than 50. Assembly shall meet the requirements of UL-181.

C. Where flexible duct is allowed, it shall be connected to metal ducts, terminal units and diffusers with Panduit, Tylon or equal tool installed nylon clamps.

D. Maximum length of flexible duct connections from metal duct to terminal units and grilles, registers and diffusers shall be not greater than 72”. All duct turns greater than 45 deg. shall be rigid elbows.
E. Wherever ductwork is routed exposed, flexible ductwork is not acceptable. All exposed ductwork to be rigid.

2.06 HINGED WALK-IN ACCESS DOORS

A. Install hinged walk-in access doors plumb and level in duct/plenum at locations and with orientations indicated on the plans. Doors shall swing in when installed in positively pressurized ducts/plenums and out when installed in negatively pressurized ducts/plenums. Seal door frame airtight to the duct/plenums.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which duct accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install duct accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.

B. Install access panels for inspection and servicing of all duct mounted equipment including, but not limited to: reheat coils, sound attenuators, motorized dampers, airflow measuring stations, smoke and fire dampers.

C. Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.

D. Install all fire and smoke dampers in accordance with manufacturer's installation instructions.

E. Coordinate with other work, including ductwork, as necessary to interface installation of duct accessories properly with other work.

F. Field Quality Control: Operate installed duct accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leakproof performance.

G. Coordinate installation of smoke damper switch package and indicating lights with Electrical Contractor. Switch package to be provided by HVAC Contractor.

H. Furnish General Contractor with layout and size of wall openings. Coordinate installation of louver with General Contractor. Make duct connections to louvers as shown on the plans.

END OF SECTION 23 33 00
PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this Section.

1.02 DESCRIPTION OF WORK

A. Extent of centrifugal HVAC fan work is indicated on drawings and schedules, and by requirements of this section.

B. Types of centrifugal fans required for this project include the following:

1. Utility Fans
2. In-line Cabinet Fans
3. In-line Centrifugal Fans

C. Vibration isolation required for air distribution equipment is specified in other Division-23 sections, and is included as work of this section.

D. Refer to Division-26 sections for power work required in conjunction with air distribution equipment; not work of this section.

1.03 QUALITY ASSURANCE

A. AMCA Compliance: Provide air distribution equipment bearing the Air Movement and Control Association, Inc. (AMCA) Certified Ratings Seal.

B. UL Compliance: Provide air distribution equipment electrical components which have been listed and labeled by Underwriters Laboratories (UL).

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver centrifugal fans with factory-installed shipping skids and lifting lugs; pack components in factory-fabricated protective containers.

B. Handle centrifugal fans carefully to avoid damage to components, enclosures, and finish. Do not install damaged components; replace and return damaged components to centrifugal fan manufacturer.

C. Store air distribution equipment in clean dry place and protect from weather and construction traffic.

1.05 SUBMITTALS

A. Submittal data shall include physical dimensions, fabrication details, materials, fan curves, sound ratings, motor size and electrical characteristics and required brake horsepower for specified operating conditions.
PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Utility Fans

1. Greenheck
2. Penn Barry
3. Loren Cook Co.
4. Twin City Fan & Blower
5. Solar & Palau
6. Acme

B. In-line Cabinet Fans

1. Greenheck
2. Carnes
3. Penn Barry
4. Loren Cook Co.
5. Twin City Fan & Blower
6. Solar & Palau
7. Acme

C. In-Line Centrifugal Fans

1. Greenheck
2. Carnes
3. Penn Barry
4. Loren Cook Co.
5. Twin City Fan & Blower
6. Solar & Palau
7. Acme

2.02 UTILITY FANS

A. General: Provide utility fans of sizes and arrangement as indicated, and of capacities and having accessories as scheduled.


C. Fan Units: Provide Factory-assembled and tested fan units consisting of housing, wheel, fan shaft, bearings and fan drive. Clean, condition, and prime paint sheet metal parts prior to final assembly. Apply final coat of enamel to exterior surfaces after assembly.

D. Housings: Construct of heavy-gage steel with side sheets fastened to scroll sheets by means of deep lock seam. Provide round inlet collar, slip joint discharge duct connection. Construct housing to be convertible to 8 standard discharges. Provide adjustable motor supports.

E. Wheels: Provide forward curved or backward inclined wheels as scheduled. Provide swaged hubs. Balance wheels statically and dynamically. Fan wheel classification must be capable of maximum rpm achievable based on the motor horsepower provided.

F. Shafts: Construct of AISC C 1040 ground and polished steel. Apply rust-preventive coating.
G. Bearings: Provide self-aligning, grease-lubricated, pillow block type bearings, selected for minimum average life (AFBMA L 50) of 200,000 hours.

H. Motors: Provide open drip-proof motors with ball or sleeve bearings. Provide split phase or capacitor start motors for fractional horsepower, with resilient base. Provide induction motors for integral horsepower, with rigid base.

I. Drives: Provide V-belt drives for fractional horsepower motors selected for 1.2 service factor. Provide V-belt drives for integral horsepower motors selected for 1.4 service factor. Provide adjustable pitch sheave, selected for midpoint at design conditions.

2.03 IN-LINE CABINET FANS

A. General: Provide duct mounted supply, exhaust or return fans of the centrifugal, belt driven in-line type.

B. Ratings: All fans shall bear the AMCA Certified Ratings Seal for air performance.

C. Casing: The fan housing shall be of the rectangular design constructed of heavy gauge galvanized steel and shall include rectangular duct mounting collars. A hinged or removable panel shall be provided in the fan cabinet of sufficient size to permit access for service to all of the fan’s internal components without dismantling the cabinet.

D. Fan: The fan wheel shall be of the galvanized steel, forward curved, centrifugal type. Wheels shall be dynamically and statically balanced.

E. Motor: Heavy duty type with permanently sealed ball bearings. The wheel shaft shall be ground and polished steel mounted in permanently sealed pillow block bearings.

F. Drives: For belt drive units a drive shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the machined cast iron type, keyed and securely attached to the wheel and motor shafts. The motor pulleys shall be adjustable for final system balancing.

G. Accessories:
   1. Insulated Housing
   2. Disconnect switches
   3. Spring Vibration Isolators

2.04 IN-LINE CENTRIFUGAL FANS

A. General: Provide fans of sizes and arrangement and capacities as indicated on schedule. Fans shall be tested and rated in accordance with ASHRAE Standard 51 (AMCA Standard 210). Fans shall bear the AMCA Certified Rating Seal for both sound and performance.

B. Housing: Heavy duty galvanized steel with square duct mounting collars and removable access panels for ease of maintenance.

C. Fan Wheel: Centrifugal backward inclined, aluminum, with wheel and inlet cones. Fan wheels shall be statically and dynamically balanced. Fan wheel classification must be capable of maximum rpm achievable based on the motor horsepower provided.

D. Fan Shaft shall be solid AISI-C1040 hot rolled steel, turned and polished. Close tolerances to be maintained where shaft makes contact with bearings.
E. 
Bears
tions: Fans shall have precision, flange-mounted, self-aligning ball bearings at inlet and discharge. Bearings are to be grease lubricated and selected for a minimum average life (AFBMA L-50) in excess of 200,000 hours at maximum cataloged operating conditions. Grease lines extend to exterior of fan housing.

F. 
Motors: Provide open drip-proof motors with ball or sleeve bearings. Provide split phase or capacitor start motors for fractional horsepower, with resilient base. Provide induction motors for integral horsepower, with rigid base.

G. 
Drives: Provide V-belt drives for integral horsepower motors selected for 1.4 service factor. Provide adjustable pitch sheave, selected for midpoint at design conditions.

H. 
Provide NEMA 1 disconnect switch with built-in overload protection.

I. 
Finish: All surfaces to have factory primed and painted. Exterior is to have an enamel finish.

J. 
Accessories:
1. Insulated Housing
2. Disconnect Switches
3. Spring Vibration Isolators
4. Motor Cover
5. Belt Cover
6. Backdraft Damper

PART 3 - EXECUTION

3.01 INSPECTIONS

A. 
Examine areas and conditions under which centrifugal fans are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF CENTRIFUGAL FANS

A. 
Install centrifugal 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.

B. 
Coordinate with other work, including ductwork and electrical work as necessary to interface installation of centrifugal fans with other work.

C. 
Install units with vibration isolators or isolation bases, complying with Division-23, Section 23 0548 - Vibration and Seismic Controls for HVAC Piping and Equipment.

3.03 ELECTRICAL CONNECTIONS

A. 
Ensure centrifugal fans are wired properly, with rotation in direction indicated and intended for proper performance.

B. 
Provide positive electrical equipment and motor grounding.
3.04 FIELD QUALITY CONTROL

A. Upon completion of installation of centrifugal fans, and after motor has been energized with normal power source, test equipment to demonstrate compliance with requirements. Where possible, field correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment which cannot be satisfactorily corrected.

3.05 BALANCING

A. Refer to Division 23, Section 23 05 93 - Testing, Adjusting and Balancing for HVAC of fan systems; not work of this section.

3.06 SPARE PARTS

A. General: Furnish to owner, with receipt, 1 spare set of belts for each belt driven equipment item.

END OF SECTION 23 34 16
SECTION 23 37 13 - DIFFUSERS, REGISTERS AND GRILLES

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Provide material, equipment, labor and supervision necessary for the installation of grilles, registers and diffusers as per the schedules on the drawings.

1.03 SUBMITTALS

A. Submit manufacturer's catalog cuts for each type of device to be used.

B. Product Data: For each product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.

2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Acceptable Manufacturers

1. Carnes
2. Titus
3. E.H. Price
4. Metal Aire
5. Krueger
6. Nailor

2.02 Diffusers, registers, and grilles shall be of the type and style as scheduled.

PART 3 - EXECUTION

3.01 Install wall mounted grilles and registers plumb and level and flush to surface. Locations may be altered slightly, as acceptable to the Design Professional, so as to fit masonry portions of the structure.

3.02 In grid panel type ceilings, lay-in metal pan, acoustical, etc., grilles, registers and diffusers shall be located in the center of the panel.

3.03 Coordinate locations of ceiling diffusers and registers with Design Professional's reflected ceiling plan. Where architectural features or other items conflict with installation, notify Design Professional for determination of final location.

3.04 Adjust blow pattern as indicated on plans and as scheduled, prior to balancing.

END OF SECTION 23 37 13
PART 1 - GENERAL

1.01 RELATED WORK
A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this Section.

1.02 DESCRIPTION OF WORK
A. Extent of commercial kitchen exhaust work required by this section is indicated on drawings and schedules, and by requirements of this section.
B. Types of commercial kitchen exhaust equipment specified in this section include the following:
   1. Kitchen Hood Exhaust Fan
C. Refer to Division-26 sections for the following; not work of the section.
   1. Power supply wiring from power source to power connection on exhaust fans. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.
D. Provide the following electrical work as work of this section, complying with requirements of Division-26 sections:
   1. Control wiring between field-installed controls and indicating devices.

1.03 QUALITY ASSURANCE
A. Codes and Standards
   1. NFPA Compliance:
      a. Install kitchen exhaust equipment in accordance with NFPA 96.
      2. Install kitchen exhaust equipment in accordance with all local codes.

1.04 SUBMITTALS
A. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, weights, furnished specialties and accessories; installation and start-up instructions, fan curves, sound ratings, motor size and electrical characteristics and required horsepower for specified operating conditions.
B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.
C. Maintenance Data: Submit maintenance data and parts list for each type of equipment, control, and accessory; including "trouble-shooting" maintenance guide. Include this data and product data in maintenance manual.
1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Handle equipment and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged equipment or components; replace with new.

B. Store equipment and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

C. Comply with Manufacturer's rigging and installation instructions for unloading equipment and moving them to final location.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Kitchen Hood Exhaust Fans
   1. Carnes
   2. Greenheck Fan Corporation
   3. Loren Cook

2.02 KITCHEN HOOD EXHAUST FAN

A. Roof exhaust fans shall be of the belt drive, upblast, vertical discharge type and shall be UL 762 listed to meet NFPA 96. Housings shall be constructed of heavy gauge aluminum. The windband shall have a rolled bead and additional structural members for added strength. The fan wheel shall be of the backward inclined, centrifugal type, constructed of aluminum and statically and dynamically balanced for smooth, vibration free operation. Fan wheel classification must be capable of maximum rpm achievable based on the motor horsepower provided.

B. Construction shall include a built-in grease drain. Motors and drives shall be isolated from the airstream. Motors shall be permanently lubricated, heavy duty, ball bearing type, carefully matched to the fan load and furnished at the specified voltage, phase and enclosure. Motors shall be cooled by air drawn from outside the exhaust airstream. The fan shaft shall be ground and polished steel mounted on heavy duty ball bearings. Bearings shall be selected for a minimum average (L50) life in excess of 200,000 hours at maximum cataloged operating speeds.

C. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts. Motor sheaves shall be adjustable for final system balancing. Drives shall be sized for a minimum of 150% of driven horsepower. The entire fan and motor assembly shall be mounted on vibration isolators to prevent noise transmission.

D. The roof exhaust fans shall bear the AMCA certified ratings seals for air and sound performance.

E. Each unit shall be equipped with the following accessories:
   1. Expanded aluminum bird screen
   2. Variable pitch motor pulley
   3. Automatic belt tightener
   4. Vented 18" roof curb
   5. NEMA 3R disconnect
PART 3 - EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which equipment is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF KITCHEN HOOD EXHAUST FAN

A. Furnish General Contractor with layout and size of roof openings and curbs.

B. Furnish Electrical Contractor with power requirements, electrical characteristics and required rough-in for each motor.

C. Make duct connections and install fans as indicated on drawings.

D. Secure curb cap of roof mounted fans to wood nailer on roof curb within 3" of corners and 18" on center with non-ferrous, cadmium plated or stainless steel lag screws using weather resistant gaskets to form a watertight connection.

END OF SECTION 23 38 13
SECTION 23 52 16 - CONDENSING BOILERS

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of the Contract Forms, the Conditions of the Contract, General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Extent of gas-fired boiler work required by this section is indicated on drawings and schedules, and by requirements of this section.

B. Types of gas-fired boiler specified in this section include the following:


C. Refer to other Division-23 sections for concrete pads, piping, specialties, pumps, breechings, etc., required external to boilers for installation; not work of this section.

D. Refer to Division-26 sections for field-installed power wiring required for gas-fired boilers; not work of this section.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:


2. ASME Compliance:
   a. Construct gas-fired boilers in accordance with American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section IV.
   b. Install gas-fired boilers in accordance with ASME-CSD-1, Controls and Safety Devices for automatically fired boilers.

3. UL Labels: Provide gas-fired boiler ancillary electrical components which have been listed and labeled by Underwriters Laboratories (UL).


1.04 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, weights (shipping, installed and operating), furnished specialties and accessories and installation and start-up instructions.

B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances and methods of assembly of components.
C. Wiring Diagrams: Submit ladder-type wiring diagrams for power and control wiring required for final installation of boilers and controls. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Handle boiler and equipment carefully to prevent damage, breaking and scoring. Do not install damaged equipment or components; replace with new.

B. Store boiler and equipment in clean, dry place. Protect from weather, dirt, fumes, water, construction debris and physical damage.

PART 2 - PRODUCTS

2.01 APPROVED MANUFACTURERS

A. High Efficiency Modular Gas-fired Boilers

2. Laars

2.02 PACKAGED GAS-FIRED BOILERS

A. General: A certified Hydro-Pulse contractor shall furnish and install, where indicated, in accordance with manufacturer's instructions and in compliance with all rules and regulations of authorities having jurisdiction, gas-fired pulse combustion National Board registered modular hot water boilers complete with one or more batteries of boiler modules and all accessories.

B. Heating plant shall be A.G.A. design certified for capacity as scheduled on the drawings and shall be designed for automatic operation with natural gas.

C. For operation with natural gas, the gas line must be designed to deliver a minimum supply pressure to the gas valves of 4.5" W.C. and a 7" W.C. maximum.

D. Each module shall be completely factory-assembled to include a molded combustion air inlet chamber, a pre-purge/post-purge blower assembly, an air-gas fuel control valve, a cast bronze pulse combustion chamber, a welded steel absorption unit with spiraled fire tubes, and a molded exhaust chamber. This assembly shall be housed in an insulated jacket which includes a boiler mounted electrical control panel enclosure with operation sequence indicator lights. Couplings shall be provided on the combustion air inlet and exhaust chambers for connections to plastic tubing--PVC for outside air intake and CPVC for outside exhaust. A condensate drain fitting shall be provided on the exhaust chamber.

E. The absorption unit shall be constructed in accordance with Section IV of the ASME Code for Low Pressure Heating Boilers. It shall be constructed for 100 psi working pressure for Model M-150 modules.

F. The controls provided for each module shall include a Hydro-Pulse solid state controller with circulator relay, fan prove pressure switch and pressure sensing flame safeguard system. A combination gas control shall be provided with a manual shutoff valve, a system pressure controlled regulator, and automatic redundant control valves. A single high limit water temperature controller, ASME approved pressure relief valve, and a temperature/pressure indicator shall be provided.
G. Gas controls on each module shall be factory-wired, tested and suitable for firing each module individually. Step firing of each module shall be accomplished by firing individual boilers without reducing their thermal efficiency. Control system may be designed and provided for the heating plant by the manufacturer and included in system design with factory wiring of controller into a designated control panel.

H. Each module is to be vented individually. The certified contractor shall install an air intake for use of outdoor air for combustion, and an exhaust line to the outdoors to vent the products of combustion of each boiler module.

I. Manufacturer shall provide an approved engineering drawing of the modular installation including piping, wiring and controls. After completion of installation, the heating plant shall be test started in the presence of a representative of the boiler manufacturer.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which boiler is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF BOILER

A. General: Comply with boiler manufacturer's instructions for installation, except as otherwise indicated.

B. Comply with installation requirements of local and state boiler codes, and applicable provisions of NFPA and ASME boiler code standards.

C. Install boilers on 4" high concrete pad where indicated, maintain manufacturer's recommended clearances around and over top of boilers.

D. Install boiler trim not installed at factory.

E. Connect water and fuel piping and breeching as indicated.

F. Furnish to Electrical Installer, manufacturer's wiring diagram and electrical requirements for installation of field-wiring required for power to boilers; not work of this section.

G. Flush and clean boilers upon completion of installation, in accordance with manufacturer's start-up instructions.

H. Start-up boiler, in accordance with manufacturer's start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

I. Hydrostatically test assembled boiler and piping in accordance with applicable sections of ASME Boiler and Pressure Vessel Code.

3.03 TRAINING OF OWNER'S PERSONNEL

A. Provide services for manufacturer's technical representative to instruct Owner's personnel in operation and maintenance of boiler.
B. Schedule training with Owner, provide at least 7 day notice to Contractor and Design Professional of training date.

END OF SECTION 23 52 16
SECTION 23 62 00 - PACKAGED COMPRESSOR AND CONDENSER UNITS

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this Section.

1.02 DESCRIPTION OF WORK

A. Extent of condensing unit work required by this section is indicated on drawings and schedules, and by requirements of this section.

B. Types of condensing units in this section include the following:
   1. Air-cooled condensing units.

C. Refer to other Division-23 sections for piping, refrigeration specialties, etc., required external to condensing units for installation; not work of this section.

D. Refer to Division-26 sections for field-installed power wiring required for condensing units; not work of this section.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:
   3. UL Compliance: Provide condensing units which are listed by Underwriters Laboratories (UL) and have UL label affixed.

B. Warranty:
   1. Provide one year warranty on all parts except compressor.
   2. Provide five year warranty on compressor.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's equipment specifications, equipment capacities, ratings and selection points and installation and start-up instructions.

B. Shop Drawings: Submit manufacturer's assembly type shop drawings indicating dimensions, weight loadings, required clearances and method of assembly of components.

C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring. 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.
1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Handle condensing units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged condensing units or components; replace with new.

B. Store condensing units and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris and physical damage.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Air-cooled Condensing Units

1. Lennox Industries, Inc. (units up to 15 tons)
2. Trane Company
3. Daikin Applied
4. Johnson Controls

2.02 GENERAL

A. Provide factory-assembled and tested air-cooled condensing units as indicated, consisting of compressor, condenser coil, fan, motor, refrigerant reservoir, and operating controls. Provide capacity and electrical characteristics as scheduled.

2.03 UNITS UP TO 5 TONS

A. Casing: Provide 18 gauge galvanized steel casing finished with baked enamel. Provide removable panel for access to controls, and weep holes for drainage. Provide base with mounting holes. Provide brass service valves, fittings, and gage ports on exterior of casing.

B. Compressor: Provide welded hermetic with built-in overloads and vibration isolation. Provide for compressor motor, thermal and current-sensitive overload device, internal high-pressure protection, high and low pressure cutout switches, start capacitor and relay, 2-pole contactor, crankcase heater, and temperature actuated switch and timer to prevent compressor rapid cycle.

C. Condenser: Construct coil of copper tubes and aluminum fins, provided with liquid accumulator and liquid subcooler. Provide aluminum propeller fan, direct driven, with permanently lubricated fan motor with thermal overload protection.

D. Provide the following accessories:

1. Low-voltage thermostat to control condensing unit and evaporator fan. Provide 7-day programmable thermostat with individual temperature setpoints for occupied heat and cool and unoccupied heat and cool. Thermostat shall have automatic heat/cool changeover, 3-hour override of unoccupied program and battery backup. Thermostat shall be Honeywell T-7200.
   a. In the occupied mode, the fan shall run continuously. In the unoccupied mode the fan shall cycle.
   b. In the occupied mode the outdoor air damper shall open. In the unoccupied mode, it shall close.

2. Precharged and insulated suction and liquid tubing of length indicated. (Contractor option.)

3. Head pressure control to modulate condenser fan motor speed for low ambient conditions.

4. Low voltage control transformer.

5. Low and high pressure switches
6. Crankcase heater
7. Filter dryer
8. Anti short cycle control

2.04 UNITS FROM 7-1/2 TO 15 TONS

A. Casing:
   1. Casing shall be constructed of 18 gauge galvanized steel.
   2. Exterior surfaces shall be cleaned, phosphatized and finished with a weather resistant baked enamel finish.
   3. Unit surfaces shall be tested 500 hours in salt spray test.
   4. Units shall have removable end panels which allow access to all major components and controls.

B. Compressors:
   1. 7-1/2 Tons:
      a. Single direct drive hermetic reciprocating compressor.
      b. Unit shall include oil pump, crank case heater, temperature and current overloads, internal spring isolation, and external high and low pressure cutout devices.
   2. 10 - 20 Tons:
      a. Dual direct drive hermetic reciprocating compressors.
      b. Unit shall include oil pump, crank case heater, temperature and current overloads, internal spring isolation, and external high and low pressure cutout devices.

C. Refrigerant Circuits:
   1. 7-1/2 Tons: Single Refrigerant Circuit.
   2. 10 - 20 Tons: Dual Refrigerant Circuits.
   3. Each refrigerant circuit shall have the following:
      a. Integral subcooling circuit.
      b. Filter dryer.
      c. Liquid and suction line service valves and gauge port.

D. Condenser:
   1. Condenser coils shall be constructed of aluminum fins mechanically bonded to seamless copper tubing. Condensers shall be factory leak tested at 450 psig air pressure underwater.
   2. Provide with direct drive, statically and dynamically balanced vertical discharge fins.
   3. Motors shall have permanently lubricated ball or sleeve bearings and thermal overload protection.

E. Provide the following:
   1. Factory wired controls.
   2. Anti-short cycle times.
   3. Low ambient operation to 0°F.
   4. Hot gas bypass lite.
   5. Time delay relay.
   6. Condenser coil guard.
   7. Non-fused disconnect.
2.05 UNITS FROM 20 TO 60-TONS

A. Casing:
   1. Casings shall be constructed of a 14-gauge welded galvanized steel frame. Panels and access doors shall be 14 and 16-gauge galvanized steel.
   2. The unit surface shall be phosphatized and finished with air-dry paint which shall exceed 500 consecutive hour salt spray resistance in accordance with ASTM B117.
   3. Provide units with factory-installed decorative louvered grills to protect the condenser coils.

B. Compressor:
   1. Compressors shall be scroll or reciprocating type.
   2. Unit shall include centrifugal oil pump, inlet dirt separator, journal bearings, oil sight glass, oil charging valve and solid internal suspension.

C. Condenser:
   1. Condenser coils shall be constructed of aluminum fins mechanically bonded to seamless copper tubing with an integral subcooler. Condensers shall be factory leak tested at 450 psig air pressure underwater.
   2. Provide with direct drive, statically and dynamically balanced vertical discharge fans.
   3. Three-phase motors shall have permanently lubricated ball bearings and thermal overload protection.

D. Refrigerant Circuits and Capacity Modulation:
   1. 20 through 30-ton sizes shall be single circuit and have two steps of capacity.

E. Provide with the following accessories:
   1. Low ambient controls to allow operation down to 0°F.
   3. Non-fused disconnect.
   4. Multi-step, demand oriented microprocessor-based discharge air controller, equal to Honeywell W7100A, including discharge air sensor (VAV applications only).
   5. Coil frost protection controls (VAV applications only).

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which condensing units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Contractor.

3.02 INSTALLATION OF CONDENSING UNITS

A. General: Install condensing units in accordance with manufacturer’s installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer’s recommended clearances.

B. Support: Install ground mounted units on 4” thick reinforced concrete pad, 4” larger on each side than condensing unit. Anchor unit to pad using inserts or anchor bolts.
C. Electrical: Furnish electrical field-wiring diagrams to Electrical Contractor for power wiring to condensing units.

D. Air-Cooled Condensing Units: Connect refrigerant piping to unit; run piping so as to not interfere with access to unit.
   1. Install furnished field-mounted accessories.
   2. Refrigerant piping shall be insulated in accordance with the requirements of Section 23 07 00 – HVAC Insulation.
   3. All control wiring shall be the responsibility of the HVAC Contractor.
   4. Install flexible piping connection for units mounted on spring isolators.

E. Start up condensing units, in accordance with manufacturer's start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

3.03 TRAINING OF OWNER'S PERSONNEL

A. Instruct Owner's personnel in operation and maintenance of condensing units.

END OF SECTION 23 62 00
PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Extent of energy recovery units work required by this section is indicated on drawings and schedules, and by requirements of this section.

B. Refer to Division-26 sections for the following work:
   1. Power supply wiring from power source to power connection on energy recovery units. Include disconnects and required electrical devices, except where specified as furnished, or factory-installed by manufacturer.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. UL Compliance: Provide energy recovery units which are designed, manufactured and tested in accordance with UL requirements.
   2. ARI Compliance: Units shall have certified ratings complying with ARI Standard 1060.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's equipment specifications, equipment capacities, ratings and selection points, fan curves with selection points clearly indicated and installation and start-up instructions.

B. Shop Drawings: Submit manufacturer's assembly type shop drawings indicating dimensions, weight loadings, required clearances and method of assembly of components.

C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to heat recovery equipment including control and thermostat wiring. 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.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Handle energy recovery units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged energy recovery units or components; replace with new.

B. Store energy recovery units and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris and physical damage.

C. Comply with manufacturer's rigging and installation instructions for unloading energy recovery units, and moving them to final location.
PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Energy Recovery Units
   1. Venmar
   2. Greenheck
   3. Semco

2.02 ENERGY RECOVERY UNITS

A. General: Packaged, energy recovery ventilation system consisting of supply and exhaust fans, enthalpy wheel heat exchanger with thermal transfer media, wheel drive system and variable frequency drive, heating/cooling coils, filters, unit casing and access doors, and necessary temperature sensors, gauges, and microprocessor controls.

B. Unit Cabinet:
   1. Cabinet shall be constructed of 18 gauge G-90 galvanized steel with 12 gauge galvanized frame. Unit to be internally lined with galvanized steel to create a double wall.
   2. Unit shall be provided with inlet and discharge duct collars.
   3. Access panels shall be provided for unit controls, fans, and motors, wheel and motor, coils and filters.
   4. Insulation: 1" fiberglass or injected foam insulation within double wall construction.
   5. Outdoor Units: Casing to be weather-resistant, steel with baked-on enamel finish.

C. Energy Recovery Wheel:
   1. Media: Uni-directional, fluted construction for laminar air flow.
   2. Construction: Corrugated aluminum coated with non-migrating permanently bonded desiccant. Media shall be non-asbestos, water resistant, bacteriostatic and fire retardant (meeting NFPA 90A flame spread and smoke generation requirements for installation in air duct). Media shall be strengthened with radial reinforcement.
   3. Wheel: Heavy gauge steel frame wheel with self-aligning sealed bearings. Wheel shall be installed in a heavy duty removable "cassette" to facilitate access. Nylon wiping seals at periphery of the rotor and along supply and exhaust divider.
   4. Purge: Purge section between supply and exhaust to limit contamination to the supply air to .04 percent.
   5. Drive: Totally enclosed motor with in-line speed reducer with belt and sheave on rotor rim. Variable frequency drive shall modulate rotational speed as required for discharge temperature and frost control.
   6. Access: Enthalpy wheel shall be removable from the unit through side access doors.

D. Supply and Exhaust: Provide forward-curved, centrifugal, belt-driven fans with adjustable sheaves and permanently lubricated motor bearings. Fan and motor assemblies shall be isolated from the unit with spring vibration isolation and flexible duct connections.
   1. Fan and sheave combinations shall be selected to operate at design conditions without exceeding variable frequency drive speeds of 100 Hz. Combinations requiring operation above 100 Hz are not acceptable.
   2. Fan wheel classification must be capable of maximum rpm achievable based on the motor horsepower provided.

E. Coils
   1. Coils shall be furnished for heating/cooling as scheduled on the drawings.
2. Coils shall be aluminum fin, copper tube type. Fins shall have drawn, belled collars bonded to the tubes by means of mechanical expansion of the tubes. Coil casings shall be galvanized steel. Coils shall be 12 fpi or less.

3. Full sized double-sloped drain pan under cooling coil and supply fan. Drain pan shall comply with ASHRAE 62.1.

4. Coils shall be factory tested and rated in accordance with ARI-410.

F. Filters: Angle filter racks designed to hold 2" pleated throw-away filters. Provide with full size access door. Filters to be minimum MERV-8A unless noted otherwise.

G. Supply and Exhaust Dampers: Low leak type, metal compressible jamb seals and extruded vinyl blade edge seals, mechanically locked into the blade edge, on both the outdoor air and exhaust air. Leakage shall not exceed 5 cfm/sf at one-inch wg. All leakage testing and pressure ratings will be based on AMCA Publication 500. Dampers to be motorized. Supply damper to be located at outdoor inlet side of unit. Exhaust damper to be located at exhaust discharge side of unit.

H. Electrical

1. Single point power connection for supply fan, exhaust fan, wheel drive, VFD, and controls. Unit to have control transformer for 24 VAC for controls devices.

2. Disconnect: Unit shall come equipped with a non-fused disconnect with single power point connection.

3. Starters: Provide motor starters (as required) for exhaust and supply fans. Starters mounted within control enclosure.

I. Controls

1. Unit shall be provided with a factory mounted and factory wired microprocessor control.

2. All service connectors shall be quick disconnect type.

3. Unit circuitry shall allow the following operational characteristics:
   a. Dry contacts for occupancy (on/off) control from building automation system.
   b. Static pressure and outside air temperature sensors for frost detection.
   c. VFD drive speed control to decrease wheel rotation as required to for frost control.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which energy recovery units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF ENERGY RECOVERY UNITS

A. General: Install energy recovery units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

B. Chilled/Heating Water Piping: Refer to Division 23, Section 23 05 00 - HVAC Water Treatment Connect supply and return piping to unit. Provide flexible pipe connectors.

C. Controls: Install devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Contractor for power wiring.

1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.
D. Ductwork (if applicable): Refer to Division 23, Section 23 31 13 – Metal Ducts. Connect supply and return ducts to unit with flexible duct connections. Provide transitions to exactly match unit duct connection size.

E. Start-up of energy recovery units shall be in accordance with manufacturer's start-up instructions and shall be performed by Factory authorized technicians. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

F. Condensate Drain: Extend to nearest floor drain and elbow into drain. Condensate waste shall be trapped at drain pan, with screwed cleanout plug in low point of trap.

3.03 TRAINING OF OWNER’S PERSONNEL

A. Instruct Owner's personnel in operation and maintenance of energy recovery units.

3.04 SPARE PARTS

A. General: Furnish to Owner, with receipt, the following spare parts for each energy recovery unit:

1. One replacement belt for unit.
2. One set of spare supply and exhaust filters.

END OF SECTION 23 72 00
SECTION 23 74 00 - PACKAGED OUTDOOR HVAC EQUIPMENT

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Extent of packaged outdoor HVAC equipment work required by this section is indicated on drawings and schedules, and by requirements of this section.

B. Types of rooftop heating and cooling units specified in this section include the following:
   1. Packaged rooftop units.

C. 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 packaged outdoor HVAC equipment. Include required electrical devices except where specified as furnished, or factory-installed by manufacturer.

D. Refer to other Division-23 sections for ductwork required external to rooftop heating cooling units for installation; not work of this section.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. ARI Compliance: Provide capacity ratings for packaged outdoor HVAC equipment in accordance with ARI standard 360 "Standard for Commercial and Industrial Unitary Air-Conditioning Equipment".
   2. ASHRAE Compliance: Construct refrigerating system of packaged outdoor HVAC equipment in accordance with ASHRAE Standard 15 "Safety Code for Mechanical Refrigeration".
   3. ASHRAE Compliance: Provide Energy Efficiency Ratio (EER) of packaged outdoor HVAC equipment not less than prescribed by ASHRAE 90A "Energy Conservation in New Building Design".
   4. UL Compliance: Provide packaged outdoor HVAC equipment which are listed by UL and have UL label affixed.
   5. AGA Compliance: Construct gas-fired furnace sections in accordance with AGA safety standards, and provide AGA label.

B. Warranty:
   1. Provide one year warranty on all parts except compressor.
   2. Provide five year warranty on compressor.
1.04 SUBMITTALS

A. Product Data: Submit manufacturer's equipment specifications, equipment capacities, ratings and selection points, fan curves with selection points clearly indicated and installation and start-up instructions.

B. Shop Drawings: Submit manufacturer's assembly type shop drawings indicating dimensions, weight loadings, required clearances and method of assembly of components.

C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to packaged heating and cooling equipment including control and thermostat wiring. 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.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Handle packaged outdoor HVAC equipment and components carefully to prevent damage, breaking, denting, and scoring. Do not install damaged packaged outdoor HVAC equipment or components; replace with new.

B. Store packaged outdoor HVAC equipment and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

C. Comply with manufacturer's rigging and installation instructions for unloading packaged outdoor HVAC equipment and moving them to final location.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Packaged Rooftop Units

1. Daikin Applied
2. Trane Co., The
3. Johnson Controls

2.02 ROOFTOP UNITS, 7-1/2 to 17 TONS

A. General: Provide factory-assembled and tested rooftop units as indicated, designed for roof or slab mounting, consisting of compressors, condensers, evaporator coils, condenser and evaporator fans, refrigeration, heat exchangers and temperature controls, filters, and dampers. Provide capacities and electrical characteristics as scheduled.

B. Casing: Provide manufacturer's standard casing construction, corrosion protection coating, and exterior finish. Provide removable panels and/or access doors for inspection and access to internal parts. Insulate casing with 1" thick minimum thermal insulation. Provide knockouts for electrical and piping connections. Provide condensate drain connection.

C. Evaporator Fans: Provide forward-curved, centrifugal, belt-driven fans with adjustable sheaves and permanently lubricated motor bearings. Fan wheel classification must be capable of maximum rpm achievable based on the motor horsepower provided.

D. Condenser Fans: Provide propeller-type, direct-driven fans with permanently lubricated bearings.
E. Coils: For Evaporator and condenser, provide non-ferrous construction with aluminum plate fins mechanically bonded to seamless copper tubes; with brazed tubing joints.

F. Compressors: Provide serviceable, semi-hermetic or fully hermetic compressors, in accordance with manufacturer's published technical data. Provide vibration isolators and crankcase heaters which de-energize during compressor operation.

G. Safety Controls: provide the following controls, each designed for manual reset:

1. Low pressure cutout.
2. High pressure cutout.
3. Compressor motor overload protection.


1. Controls: Provide the following controls:
   a. Redundant gas valve.
   b. Intermittent pilot ignition.
   c. Electronic spark ignition system.
   d. High limit cutout.
   e. Forced draft proving switch.

I. Economizer Control: Provide economizer control consisting of return and outside air dampers, outside air filter, power exhaust damper, fully modulating electric control system with dry bulb control to automatically use outdoor air for free cooling when outdoor air temperature is below 55°F (adjustable).

J. Accessories: Provide the following accessories as indicated and/or scheduled.

1. Roof Curb: See Vibration Isolation specification section. Coordinate requirements with General Contractor.

2. Thermostat: Provide 7-day programmable thermostat with individual temperature setpoints for occupied heat and cool and unoccupied heat and cool. Thermostat shall have automatic heat/cool changeover, 3-hour override of unoccupied program and battery backup.

3. Filters - Provide filter section consisting of 2" thick fiberglass throwaway filters in filter rack, MERV 8A minimum or as scheduled, with maximum face velocity of 300 fpm.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which rooftop heating and cooling units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF ROOFTOP HEATING AND COOLING UNITS

A. General: Install rooftop heating and cooling units in accordance with manufacturers installation instructions. Install units plumb and level, firmly anchored in locations indicated and maintain manufacturer's recommended clearances.
B. Support: Install units on roof curb, in accordance with National Roofing Contractor's Association (NRCA) installation recommendations.

C. Controls: Install devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Contractor for power wiring only.
   1. Verify that wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

D. Ductwork: Refer to Division 23, Section 23 31 13 - Metal Ducts. Connect supply and return ducts to unit with flexible duct connections. Provide transitions to exactly match unit duct connection size.

E. Gas Piping: Refer to Division 22, Section 22 15 16 - Facility Natural Gas Piping. Connect gas piping to unit gas train with shutoff cock and drip leg.

F. Hot Water Piping: Refer to Division 23, Section 23 21 13 - Hydronic Piping. Connect hot water supply and return piping to unit. Provide flexible pipe connectors in rise to rooftop unit.

G. Start-up rooftop heating and cooling units in accordance with manufacturer's start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
   1. Balancing of unit systems is specified in Division 23, Section 23 05 93 - Testing, Adjusting and Balancing for HVAC; not work of this section.

H. Provide traps on condensate drains with a seal depth equal to unit total static pressure plus 1/2".

### 3.03 GROUNDINGS

A. Provide positive equipment ground for rooftop heating and cooling unit components.

### 3.04 TRAINING OF OWNER'S PERSONNEL

A. Provide services of manufacturer's technical representative to instruct Owner's personnel in operation and maintenance of rooftop heating and cooling units.
   1. Schedule training with Owner, provide at least 7-day notice to Contractor and Owner of training date.

### 3.05 SPARE PARTS

A. General: Furnish to Owner, with receipt, the following spare parts for each packaged heating and cooling unit:
   1. One set of matched fan belts for each belt driven fan.
   2. One set filters for each unit.

END OF SECTION 23 74 00
SECTION 23 81 28 – DUCTLESS SPLIT SYSTEM AIR CONDITIONERS

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Extent of split system air conditioner work required by this section is indicated on drawings and schedules, and by requirements of this section.

B. Types of equipment in this section include the following:
   1. Air-cooled condensing units.
   2. Heat pump terminal units.

C. Refer to other Division-23 sections for piping, refrigeration specialties, etc., required external to condensing units for installation; not work of this section.

D. Refer to Division-26 sections for field-installed power wiring required for condensing units; not work of this section.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. AHRI Compliance: Provide capacity ratings for condensing units in accordance with Air-Conditioning, Heating, and Refrigeration Institute (ARI) Standard 240 "Performance Rating for Unitary Air Conditioning and Air Source Heat Pump Equipment".
   3. UL Compliance: Provide condensing units which are listed by Underwriters Laboratories (UL) and have UL label affixed.

B. Warranty:
   1. Provide one year warranty on all parts except compressor.
   2. Provide five year warranty on compressor.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's equipment specifications, equipment capacities, ratings and selection points and installation and start-up instructions.

B. Shop Drawings: Submit manufacturer's assembly type shop drawings indicating dimensions, weight loadings, required clearances and method of assembly of components.

C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring. 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.
1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Handle condensing units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged condensing units or components; replace with new.

B. Store condensing units and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris and physical damage.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Air-cooled Condensing Units and Terminal Units

1. Mitsubishi
2. Panasonic
3. LG
4. Daikin
5. Samsung

2.02 GENERAL

A. Provide factory-assembled and tested air-cooled condensing units and heat pumps as indicated, consisting of compressor, condenser coil, fan, motor, refrigerant reservoir, and operating controls. Provide capacity and electrical characteristics as scheduled.

2.03 TERMINAL UNITS

A. General:

The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, control circuit board, fan and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. The indoor unit shall be charged with dry air before shipment from factory.

B. Unit Cabinet:

1. The cabinet shall be galvanized steel construction, low profile, horizontal ducted fan coil equipped with four corner mounting brackets.

C. Fan:

1. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
2. The indoor fan shall consist of three (3) speeds, High, Mid, and Low plus Auto Fan Mode
3. The indoor unit shall have a ducted air outlet system and ducted return air system.

D. Filter:

1. Return air shall be filtered by means of a standard factory installed return air filter.

E. Coil:

1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
2. The tubing shall have inner grooves for high efficiency heat exchange.
3. All tube joints shall be brazed with phos-copper or silver alloy.
4. The coils shall be pressure tested at the factory.
5. A condensate pan and drain shall be provided under the coil.
6. The unit shall be provided with an integral condensate lift mechanism able to raise drain water 21 – 11/16 inches above the condensate pan.
7. A drain pan level switch (DPLS1), designed to connect to the control board, shall be provided and installed on the condensate pan to prevent condensate from overflowing.
8. Both refrigerant lines to the indoor units shall be fully insulated.

F. Electrical:

1. The system shall be equipped with A-Control – a system directing that the indoor unit be powered directly from the outdoor unit using a 3-wire, 14 gauge AWG connection plus ground.

G. Controls:

1. The control system shall consist of a minimum of one microprocessor on each indoor unit and one in the outdoor unit, communicating via A-Control data over power transmission. The microprocessor located in the indoor unit shall have the capability of monitoring return air temperature and indoor coil temperature, receiving and processing commands from the wired or wireless controller, providing emergency operation and controlling the outdoor unit. The control signal between the indoor and outdoor unit shall be pulse signal 24 volts DC. Indoor units shall have the ability to control supplemental heat via connector CN24 and a 12 VDC output.
2. For A-Control, a three (3) conductor 14 gauge AWG wire with ground shall provide power feed and bi-directional control transmission between the outdoor and indoor units.
3. The system shall be capable of automatic restart when power is restored after power interruption. The system shall have self-diagnostics ability, including total hours of compressor run time. Diagnostics codes for indoor and outdoor units shall be displayed on the wired controller panel.
4. Remote Controller
   a. Wired Remote Controller
   The Wired Remote Controller shall have a built-in weekly timer with up to 8 pattern settings per day. The controller shall consist of an On/Off button, Increase/Decrease Set Temperature buttons, a Cool/Auto/Fan/Dry mode selector, a Timer Menu button, a Timer On/Off button, Set Time buttons, a Fan Speed selector, a Ventilation button, a Test Run button, and a Check Mode button. The controller shall have a built-in temperature sensor. Temperature shall be displayed in Fahrenheit (°F) and Temperature changes shall be by increments of 1°F (0.5°C).
   Field wiring shall run directly from the indoor unit to the wired controller with no splices. The control voltage from the wired controller to the indoor unit shall be 12/24 volts, DC. Up to two wired controllers shall be able to be used to control one unit.
   b. Wireless, hand held remote controller (PAR-FL32MA)
   The wireless had held remote controller (PAR-FL32MA) shall be used with a wireless receiver (PAR-FA32MA-E). The controller shall perform input functions necessary to operate the system. The wireless receiver shall be plug and fit compatible with the indoor unit.
   The controller shall have a Power On/Off switch, Mode Selector – Cool, Dry, Heat, Auto, and Powerful Modes - Temperature Setting, Timer Control and Fan Speed Selector. The indoor unit shall perform Self-diagnostic Function and Check Mode switching. Temperature changes shall be in 1°F (0.5°C) increments with a setting range of 61 to 88°F (16 to 31°C).
2.04 OUTDOOR CONDENSING UNITS

A. General:

The outdoor unit shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory.

B. Unit Cabinet:

1. The casing shall be fabricated of galvanized steel, bonderized, finished with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection. Assembly hardware shall be cadmium plated for weather resistance.

2. Two (2) mild steel mounting feet, traverse mounted across the cabinet base pan, welded mount, providing four (4) slotted mounting holes shall be furnished. Assembly shall withstand lateral wind gust up to 155 MPH to meet applicable weather codes.

C. Fan:

1. The unit shall be furnished with a direct drive, high performance propeller type fan.

2. The condenser fan motor shall be a variable speed, direct current (DC) motor and shall have permanently lubricated bearings.

3. Fan speed shall switch automatically according to the number of operating indoor units and the compressor operating frequency.

4. The fan motor shall be mounted with vibration isolation for quiet operation.

5. The fan shall be provided with a raised guard to prevent contact with moving parts.

6. The outdoor unit shall have horizontal discharge airflow.

D. Coil:

1. The outdoor unit coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.

2. The coil shall be protected with an integral guard.

3. Refrigerant flow from the outdoor unit to the indoor units shall be independently controlled by means of individual electronic linear expansion valves for each indoor unit.

4. Outdoor unit shall be pre-charged with sufficient R-410a refrigerant for up to twenty five (25) feet of refrigerant piping.

5. All refrigerant lines between outdoor and indoor units shall be of annealed, refrigeration grade copper tubing, ARC Type, meeting ASTM B280 requirements, individually insulated in twin-tube, flexible, closed-cell, CFC-free (ozone depletion potential of zero), elastomeric material for the insulation of refrigerant pipes and tubes with thermal conductivity equal to or better than 0.27 BTU-inch/hour per Sq Ft / °F, a water vapor transmission equal to or better than 0.08 Perm-inch and superior fire ratings such that insulation will not contribute significantly to fire and up to 1” thick insulation shall have a Flame-Spread Index of less than 25 and a Smoke-development Index of less than 50 as tested by ASTM E 84 and CAN / ULC S-102.

6. All refrigerant connections between outdoor and indoor units shall be flare type.

4. Compressor:

1. The compressor shall be a high performance, hermetic, inverter driven, variable speed, dual rotary type.

2. The compressor motor shall be direct current (DC) type equipped with a factory supplied and installed inverter drive package.

3. The outdoor unit shall be equipped with a suction side refrigerant accumulator.
4. The compressor will be equipped with an internal thermal overload.
5. The compressor shall be mounted so as to avoid the transmission of vibration.

5. Electrical:
   1. The outdoor unit shall be controlled by the microprocessors located in the indoor unit and in the outdoor unit communicating system status, operation, and instructions digitally over A-Control – a system directing that the indoor unit be powered directly from the outdoor unit using a 3-wire, 14 gauge AWG connection plus ground. A 12 to 24 volt DC data stream shall communicate between the units providing all necessary information for full function control.
   2. The outdoor unit shall be equipped with Pulse Amplitude Modulation (PAM) compressor inverter drive control for maximum efficiency with minimum power consumption.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which condensing units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Contractor.

3.02 INSTALLATION OF CONDENSING UNITS

A. General: Install condensing units and heat pump terminal units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

B. Support: Install ground mounted units on 4" thick reinforced concrete pad, 4" larger on each side than condensing unit. Anchor unit to pad using inserts or anchor bolts.

C. Electrical: Furnish electrical field-wiring diagrams to Electrical Contractor for power wiring to condensing units.

D. Air-Cooled Condensing Units: Connect refrigerant piping to unit; run piping so as to not interfere with access to unit.
   1. Install furnished field-mounted accessories.
   2. Refrigerant piping shall be insulated in accordance with the requirements of this section and Section 23 0700 - HVAC Insulation.
   3. Install flexible piping connection for units mounted on spring isolators.

E. Start up condensing units, in accordance with manufacturer's start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

3.03 TRAINING OF OWNER'S PERSONNEL

A. Instruct Owner's personnel in operation and maintenance of condensing units.

END OF SECTION 23 81 28
PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements and Division 01 - General Requirements are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Extent of packaged heating and cooling units work required by this section is indicated on drawings and schedules, and by requirements of this section.

B. Types of packaged heating and cooling units specified in this section include the following:

1. Blower coil units.

C. Refer to Division 26 sections for the following work:

1. Power supply wiring from power source to power connection on packaged heating and cooling units. Include disconnects and required electrical devices, except where specified as furnished, or factory-installed by manufacturer.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:

1. UL Compliance: Provide packaged heating and cooling units which are designed, manufactured and tested in accordance with UL requirements. Units shall be UL listed.

B. Warranty:

1. Provide one-year warranty on all parts.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's equipment specifications, equipment capacities, ratings and selection points, fan curves with selection points clearly indicated and installation and start-up instructions.

B. Shop Drawings: Submit manufacturer's assembly type shop drawings indicating dimensions, weight loadings, required clearances and method of assembly of components.

C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to packaged heating and cooling equipment including control and thermostat wiring. 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.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Handle packaged heating and cooling units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged packaged heating and cooling units or components; replace with new.
B. Store packaged heating and cooling units and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris and physical damage.

C. Comply with manufacturer's rigging and installation instructions for unloading packaged heating and cooling units, and moving them to final location.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Blower Coil Units

1. Johnson Controls
2. McQuay
3. Carrier
4. Trane Co.
5. Zehnder Rittling
6. Carrier
7. Airtherm
8. Price Industries
9. Xetex

2.02 BLOWER COIL UNITS

A. Furnish and install blower coil units as scheduled on the drawings.

B. Air delivery shall be as scheduled on the drawings.

C. Fan shall be forward curved, centrifugal blower type, direct drive. The fan shaft shall be supported by heavy duty permanently sealed ball bearings. Fans shall be dynamically balanced.

D. Fan motors shall have a plus or minus 10 percent voltage utilization range. All motors shall be open drip-proof with permanently sealed ball bearings, internal current and thermal overload protection, a minimum 1.15 service factor, and 56 frame resilient bases. Motors shall be factory installed and wired to the unit junction box.

E. Where indicated on the schedule on the plans, provide EC motors with the following:

1. Motors shall be brushless DC Electronically Commutated Motors (ECM) factory programmed and run tested in assembled units.
2. Provide motor controller with contacts to receive 0-10V DC input from the Building Automation System for control of the motor speed.
3. Motors shall have integral thermal overload protection with a maximum ambient operating temperature of 104F and shall be permanently lubricated.

F. Filters shall be two-inch MERV 13. Units shall have a standard flat filter rack that is sized for less than 500 feet per minute at nominal airflow. All units shall use standard filter sizes. Units equipped with MERV 13 filters shall have a rating based on ASHRAE Standard 52.2.

G. Casing shall be constructed with heavy gauge galvanized steel, insulated with 1" 1-1/2 lb density fiberglass fire resistant material to provide thermal and acoustical insulation. Coil access panels shall be located on both sides of the unit and allow easy removal of the internal coils and drain pan. Main access panels shall provide generous access to the fan, motor, and drive from both sides of the unit.
H. Provide coil with number of rows as indicated in the schedule on the plans. Fins shall be aluminum fins mechanically bonded to seamless copper tubes. Coils shall be specifically designed and circuited for water use, and factory tested with 450 psi air under water.

I. The drain pan shall be noncorrosive and double-sloped to allow condensate drainage. The drain pan shall be constructed of stainless steel. Coils shall mount above the drain pan, allowing the drain pan to be fully inspected and cleaned. The drain pan shall be removable for cleaning. The drain pan connection shall be 3/4" NPT schedule 40 stainless steel pipe. The main drain connection shall be at the lowest point of the drain pan. The auxiliary drain connection shall be provided on the same side as the main connection.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which packaged heating and cooling units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF BLOWER COIL UNITS

A. General: Install units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

B. Ductwork: Refer to Division 23 31 13 - Metal Ducts. Connect supply and return ducts to unit with flexible duct connections. Provide transitions to exactly match unit duct connection size.

C. Water Piping: Refer to Division 23, Section 23 21 13 - Hydronic Piping. Connect supply and return piping to unit as indicated.

D. Drain Piping: Connect unit drain to nearest indirect waste connection.

E. Start-up packaged heating and cooling units, in accordance with manufacturer's start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

3.03 TRAINING OF OWNER'S PERSONNEL

A. Instruct Owner's personnel in operation and maintenance of packaged heating and cooling units.

3.04 SPARE PARTS

A. General: Furnish to Owner, with receipt, the following spare parts for each packaged heating and cooling unit:

   1. One set filters for each unit.

END OF SECTION 23 82 20
SECTION 23 82 39 - UNIT HEATERS

PART 1 - GENERAL

1.01 RELATED WORK
A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK
A. Provide material, equipment, labor and supervision necessary to install unit heaters as required by the drawings and this section.

1.03 UNIT HEATERS
A. Unit heaters shall include the following:
   1. Hydronic/Steam Unit Heaters

1.04 SUBMITTALS
A. Submit shop drawings and/or catalog cuts showing technical data necessary to evaluate the equipment, to include color charts, dimensions, wiring diagrams, performance data and other descriptive data necessary to describe fully the terminal units.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS
A. Hydronic/Steam Unit Heaters and Cabinet Unit Heaters
   1. Airtherm
   2. Trane
   3. Daikin Applied
   4. Modine
   5. Vulcan
   6. Standard
   7. Sterling
   8. Ted Reed Thermal
   9. Dunham Bush
   10. Rittling

2.02 HYDRONIC/STEAM UNIT HEATERS AND CABINET UNIT HEATERS
A. Units shall have capacities and ratings and shall be of arrangement as scheduled on the drawings.
B. Units shall be furnished complete with coils, enclosures, drain pans, fans and motors as required to make complete functioning units.
C. Units to be installed in finished areas to be furnished with bonderized, phosphatized, flow-coated baked-on primer with spray applied baked-on enamels in color as selected by Design Professional.
D. Coils shall consist of seamless copper tubes mechanically bonded to aluminum fins. Maximum working pressure 125 psig and test pressure of 300 psig.

E. Motors for unit heaters shall be totally enclosed, Class 'B' insulation, with built-in overload protection, and shall be prewired to terminal strip in factory mounted junction box.

PART 3 - EXECUTION

3.01 Install units and make duct and piping connection as indicated on drawings.

3.02 Install shut-off cocks, balancing cocks, air vents, control valves and devices as required for complete installation.

3.03 Controls: Install devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Contractor for power wiring.

A. Verify that wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

END OF SECTION 23 82 39
PART 1 - GENERAL

1.01 RELATED WORK
A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this Section.

1.02 DESCRIPTION OF WORK
A. Extent of radiant floor heating system work is indicated on drawings and schedules, and by requirements of this section.
B. Furnish and install radiant floor heating system tubing, distribution manifolds, manifold to tubing fittings, compression sleeve tubing repair couplings, supervision and field engineering required for complete and proper function of the system.

1.03 QUALITY ASSURANCE
A. Tubing shall conform to ASTM F876 and ASTM F877. Tubing oxygen permeation barrier shall conform to DIN 4726.
B. Installer's Qualification: Installers shall be qualified in writing as either being certified or certifiable prior to the commencement of the installation.

1.04 SUBMITTALS
A. Provide submittals and shop drawings in accordance with the General Requirements and as specified herein. Submit shop drawings indicating schematic layout of system, including equipment, critical dimensions and tubing/slab penetration details and details for protected exposed PEX tubing.
B. Submit manufacturer's technical instructions.
C. Submit installer's certifications of training for installation of PEX floor heating systems.
D. Submit data indicating tube sizing and panel performance at the spacing and warm water temperatures selected.
E. Submit independent certification results for the tubing systems from a recognized testing laboratory.
F. Submit catalog data on all supports, tube guides, spacers and associated items necessary for the installation of the tubing and manifolds.
G. Submit approved design calculation record forms indicating sizing, performance and layout of the entire radiant floor system.

1.05 DELIVERY, STORAGE AND HANDLING
A. Deliver and store tubing and specialties in shipping containers with labeling in place. Do not expose to ultra violet light for more than 90 days.
B. Protect tubing and specialties from entry of contaminating material by installing tape or plugs in all open tube ends until installation and/or maintain tubing in the original shipping boxes or packaging until usage.

C. Unprotected tubes shall not be dragged across the ground or concrete surfaces, and shall be stored on a flat surface with no sharp edges.

D. Tube shall be protected from oil, grease, direct sunlight and other elements as recommended by manufacturer.

1.06 WARRANTY

A. The radiant floor system component manufacturer shall warrant the cross-linked polyethylene tubing to be free from defects in material and workmanship for a period of twenty-five (25) years. Warranty shall be issued upon presentation of design calculation record forms and approved site inspection reports (SIR).

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Radiant Floor Zones (RFZ-1)
   1. Rehau
   2. Uponor/Wirsbo

2.02 TUBING

A. Material: All radiant floor heating tubing shall be high density cross-linked polyethylene, type PEX-a manufactured in accordance with ASTM F877 as certified by NSF or equivalent testing organization and with an approved cell classification in accordance with ASTM D3350. All tubing shall be fully cross-linked to the specified standard prior to shipment from the manufacturing facility.

B. Temperature and Pressure Rating: Tubing shall be rated for not less than 180°F working temperature and 100 PSIG working pressure.

C. Oxygen Diffusion Barrier: Tubing shall have a co-extruded oxygen diffusion barrier capable of limiting oxygen diffusion through the tube to no greater than .10/g/m²/day at 104°F water temperature. In accordance with DIN 4726.

D. Bend Radius: The minimum bend radius for cold bending of the tube shall not be less than five (5) times the outside diameter. Bends with a radius less than stated shall require the use of a bending template as supplied by the tube manufacturer.

2.03 FITTINGS

A. Fittings shall be manufactured of brass and shall be supplied by the tubing manufacturer as part of a proven cataloged system.

B. Tube couplings shall not be embedded within the thermal mass unless expressly warranted for such installation by the manufacturer and approved by Design Professional prior to installation.
2.04 MANIFOLDS

A. Material: Supply and return distribution manifolds including piping adapters, manual balancing valves (return only), supply and return isolation valves and P/T ports.


PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's published technical manual.

B. Route tubing in orderly manner, according to layout and spacing shown in approved submittal drawings. All notes on drawings shall be followed.

C. At joints and fittings, square and clean end of tube, using a plastic tube cutter and join immediately or cap with tape to seal from contaminants. Where fittings are installed within the thermal mass, they shall be wrapped in chloride-free tape.

D. Remove all twists prior to securing tube. Fasten tubing at no more than 2 feet intervals, being careful not to twist the tube.

E. Tubing that must pass through expansion and construction joints shall be sleeved 12" on each side of the joint with an approved corrugated sleeve. Alternatively, dip the tubing below the slab into the subsoil of these locations.

F. Tubing that must pass through control joints shall be protected from the reach of the saw blade; secure tubing 6" on each side of the control joint.

G. Where tubing exits the floor, a sleeve shall be placed around the tube, with the sleeve extending a minimum of 10" into the floor and exiting by a minimum of 10".

H. After laying each circuit, cap the end of the tube with tape and label the tube's circuit numbers (supply and return), or connect to associated manifold and label tube length for balancing.

I. The heating system should be put into operation after the poured concrete thermal mass has cured a minimum of 28 days. If it is necessary to operate the heating system to prevent freezing, a maximum flow temperature of 59°F must not be exceeded while the thermal mass is curing. Gradually increase the flow temperature by 10°F each day until it reaches the maximum operating temperature.

3.02 FIELD QUALITY CONTROL

A. Filling, Testing & Balancing: Tests of hydronic heating systems shall comply with local codes, and, shall be witnessed by the Owner's representative.

   1. Pressure gauges used must show pressure increments of 1 psig and should be located at or near the lowest points in the distribution system.

   2. Charge the completed, yet unconcealed tubes with air. Do not exceed 100 psig.

   3. Use liquid gas detector or soap to check for leakage at manifold connections. Relieve air pressure.
4. Charge the completed, yet unconcealed tubes with water. Purge all air from tubes. Check the system for leakage, especially at all tube joints. Take necessary precautions to prevent water from freezing.

5. Perform a preliminary pressure test pressurizing the system to 1.5 times the maximum operating pressure, or 100 psi, whichever is greater for 30 minutes. As the tubing expands, restore pressure, first at 10 minutes into the test and again at 20 minutes. At the end of the 30 minute preliminary test, pressure must not fall by more than 8 psig from the maximum, and there shall be no leakage.

6. After performing the preliminary test, perform the main pressure test immediately. The main pressure test shall last 2 hours. The test pressure should be restored and must not fall more than 3 psig after 2 hours. No leakage should be detected.

7. Pressure shall be maintained during installation of the thermal mass.

8. Complete all inspection and test reports as supplied by the manufacturer of the system.

END OF SECTION 23 83 16
SECTION 26 00 10 - ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Refer to Division 00 - Procurement and Contracting Requirements and Division 01 - General Requirements, which all apply to work under this section.

1.02 DESCRIPTION OF WORK

A. Work shall include furnishing of all systems, equipment and material specified in this division and as called for on the electrical drawings, to include supervision, operations, methods and labor for the fabrication, installation, start-up and tests for the complete electrical installation.

B. All elements of the construction shall be performed by workmen skilled in the particular craft involved, and regularly employed in that particular craft.

C. All work shall be performed in a neat, workmanlike manner in keeping with the highest standards of the craft.

1.03 CODES AND STANDARDS

A. All work shall be done in accordance with the applicable portion of the following codes and standards:

1. National Electrical Code
2. National Fire Protection Association
3. National Electrical Manufacturers Association
4. Standards of Institute of Electrical and Electronic Engineers
5. International Building Code
6. Occupational Safety and Health Act
7. Iowa Administrative Code
8. NECA Standards
9. Americans With Disabilities Act (ADA)

B. All Contractors shall familiarize themselves with all codes and standards applicable to their work and shall notify Design Professional of any discrepancies between the design and applicable code requirements so that any conflicts can be resolved. Where two or more codes or standards are in conflict, that requiring the highest order of workmanship shall take precedence, but such questions shall be referred to Design Professional for final decision.

1.04 REQUIREMENTS & FEES OF REGULATORY AGENCIES

A. Contractor shall comply with the rules and regulations of the local utility companies. He shall check with each utility company providing service to this project and determine or verify their requirements regarding incoming services.

B. Meters for incoming services shall be selected based on the project requirements. Any questions concerning this shall be referred to Design Professional prior to bidding. Contractor shall provide the appropriate meter and associated materials if not furnished by the utility company.

C. Secure all required permits and pay for all inspections, licenses and fees required in connection with the electrical work including State of Iowa Electrical Inspections. Contractor shall post all bonds and obtain all licenses required by the State, City, County and Utility.
D. Contractor shall make all arrangements with each utility company and pay all service charges associated with new service.

1.05 ELECTRICAL DRAWINGS

A. The electrical drawings indicate in general the building arrangement only. Contractor shall examine construction drawings to become familiar with the specific type of building construction, i.e. type of structural system, floors, walls, ceilings, room finishes and elevations.

B. Drawings for the electrical work are in part diagrammatic, and are intended to convey the scope of the work and to indicate in general the location of equipment.

C. Contractor shall layout his own work and shall be responsible for determining the exact locations for equipment and rough-ins and the exact routing of conduits and raceway so as to best fit the layout of the work.

D. Contractor shall take his own field measurements for verifying locations and dimensions; scaling of the drawings will not be sufficient for laying out the work.

E. Because of the scale of the drawings, certain basic items such as couplings, pull or splice boxes may not be shown, but where such items are required by code or by other sections of the specifications or where they are required for proper installation of the work, such items shall be furnished and installed.

1.06 ACTIVE SERVICES

A. Contractor shall be responsible for verifying exact locations of all existing services prior to beginning work in that area.

B. Existing active services, i.e., water, gas, sewer, electric, when encountered, shall be protected against damage. Do not prevent or disturb operation of active services which are to remain.

C. When active services are encountered which require relocation, Contractor shall make request to authorities with jurisdiction for determination of procedures.

D. Where existing services are to be abandoned, they shall be terminated in conformance with requirements of the authorities having jurisdiction.

1.07 SITE INSPECTION

A. Contractor shall inspect the site prior to submitting bid for work to familiarize himself with the conditions of the site which will affect his work and shall verify points of connection with utilities, routing of outside conduit to include required clearances from any existing structures, trees or other obstacles.

B. Extra payment will not be allowed for changes in the work required because of Contractor's failure to make this inspection.

1.08 COORDINATION AND COOPERATION

A. It shall be Contractor's responsibility to schedule and coordinate his work with the schedule of the General Contractor so as to progress the work expeditiously, and to avoid unnecessary delays.
B. Contractor shall fully examine the drawings and specifications for other trades and shall coordinate the installation of his work with the work of the other contractors. Contractor shall consult and cooperate with the other contractors for determining space requirements and for determining that adequate clearance is allowed with respect to his equipment, other equipment and the building. The Design Professional reserves the right to determine space priority of the contractors in the event of interference between piping, conduit, ducts and equipment of the various contractors.

C. Conflicts between the drawings and the specifications or between the requirements set forth for the various contractors shall be called to the attention of the Design Professional. If clarification is not asked for prior to the taking of bids, it will be assumed that none is required and that the Contractor is in agreement with the drawings and specifications as issued. If clarification is required after the contract is awarded, such clarification will be made by the Design Professional and his decision will be final.

D. Special care shall be taken for protection for all equipment. All equipment and material shall be completely protected from weather elements, painting, plaster, etc., until the project is substantially completed. Damage from rust, paint, scratches, etc., shall be repaired as required to restore equipment to original condition.

E. Protection of all equipment during the painting of the building shall be the responsibility of the Painting Contractor, but this shall not relieve Contractor of the responsibility for checking to assure that adequate protection is being provided. Refer to Division 09 for painting protection.

F. Where the final installation or connection of equipment in the building requires the contractor to work in areas previously finished by the General Contractor, the Electrical Contractor shall be responsible that such areas are protected and are not marred, soiled or otherwise damaged during the course of such work. Electrical Contractor shall arrange with the General Contractor for patching and refinishing of such areas which may be damaged in this respect.

1.09 OPENINGS, CUTTING AND PATCHING

A. Refer to Division 1 for additional cutting and patching information.

B. Conduits and sleeves passing through all fire or smoke rated floors, roofs, walls, and partitions shall be provided with firestopping. Space between wall/floor and conduit or sleeve shall be sealed with UL listed intumescent fire barrier material equivalent to rating of wall/floor. Where conduit or sleeves pass through floors, roofs, walls and partitions that are not fire or smoke rated, penetrations shall be sealed with grout or caulk.

C. New structure:
   1. Contractor will coordinate the placing of openings and lintels in the new structure as required for the installation of the electrical work with the General Contractor.
   2. Contractor shall furnish to General Contractor the accurate locations and sizes for required openings, but this shall not relieve Contractor of the responsibility of checking to assure that proper size openings are provided. When additional cutting and patching is required due to Contractor's failure to coordinate this work, Contractor shall make arrangements for the cutting, patching, and painting required.

1.10 EXCAVATING AND BACKFILLING

A. Contractor shall do all excavating necessary for lightpole bases, underground wiring, conduit and duct banks, and shall backfill trenches and excavations after work has been inspected. Care shall be taken in excavating that walls and footings and adjacent load bearing soils are not disturbed in any way, except where lines must cross under a wall footing. Where a line must pass under a footing, the crossing shall be made by the smallest possible trench to accommodate the conduit. Excavation shall be kept free from water by pumping if necessary.
B. Backfill about the structure shall be placed, when practical, as the work of construction progresses. Backfilling on or against concrete work shall be done only when directed. Backfilling of trenches shall progress as rapidly as the testing and acceptance of the finished sections of the work will permit. Backfill shall be in accordance with Specification Division 31.

1.11 MATERIALS AND EQUIPMENT

A. All materials and equipment shall be the standard product of a reputable U.S.A. manufacturer regularly engaged in the manufacture of the specified item unless authorized in writing by Design Professional. Where more than one unit is required of the same system, they shall be furnished by the same manufacturer except where specified otherwise.

B. All material and equipment shall be installed in strict accordance with the manufacturer's recommendations.

C. The equipment specifications cannot deal individually with any minute items such as parts, controls, devices, etc., which may be required to produce the equipment performance and function as specified, or as required to meet the equipment guarantees. Such items when required shall be furnished as part of the equipment, whether or not specifically called for.

1.12 SUBMITTALS

A. Contractor shall furnish, to the Design Professional, complete sets of shop drawings and other submittal data. Contractor shall review and sign shop drawings before submittal. Refer to Division 01 specifications for additional requirements.

B. Shop drawings shall be bound into sets and cover related items for a complete system as much as practical and shall be identified with symbols or "plan marks" used on drawings. Incomplete, piecemeal or unbound submittals will be rejected.

C. Submittals required by the various sections of the Project Manual include, but are not necessarily limited to those identified in the submittal schedule below.

D. After award of contract, the contractor shall provide a completed submittal schedule including dates that the submittals will be to the Design Professional for review.

E. Submit required information on the following items:

<table>
<thead>
<tr>
<th>SPEC SECTION</th>
<th>EQUIPMENT</th>
<th>DETAIL DWGS</th>
<th>PROD DATA</th>
<th>SAMPLES</th>
<th>INSTALL METHODS</th>
<th>O &amp; M MANUAL</th>
<th>CERTIFICATE OF SYSTEM DEMONSTRATION</th>
<th>OTHER (SEE NOTES)</th>
</tr>
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<tbody>
<tr>
<td>26 05 33</td>
<td>Raceway and Boxes for Electrical Systems</td>
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<td>26 05 73</td>
<td>Short Circuit-Coordination Study/Arc Flash Hazard Analysis</td>
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<tr>
<td>26 24 16</td>
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<td>26 27 26</td>
<td>Wiring Devices</td>
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ELECTRICAL GENERAL PROVISIONS 26 00 10 - 4
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<th>SPEC SECTION</th>
<th>EQUIPMENT</th>
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<tr>
<td>26 29 13</td>
<td>Motor Starters</td>
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<td></td>
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<td>26 33 23</td>
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<td>26 33 53</td>
<td>Static Uninterruptible Power Supply</td>
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<td></td>
<td></td>
<td>X</td>
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</tr>
</tbody>
</table>

**NOTES:**
1. Provide preliminary report; refer to specification section for requirements.

F. Design Professional will review shop drawings solely to assist contractors in correctly interpreting the plans and specifications.

G. Contract requirements cannot be changed by shop drawings which differ from contract drawings and specifications.

**1.13 OPERATION AND MAINTENANCE MANUALS**

A. Operation and maintenance manuals shall be submitted to Design Professional. Refer to Division 01 specifications for additional information.

B. Submit manuals in duplicate upon completion of the job. Manuals shall be bound in a three ring hard-backed binder. Front cover and spine of each binder shall have the following lettering done:

```
OPERATION
AND
MAINTENANCE
MANUAL
FOR
ELECTRICAL SYSTEMS

(PROJECT NAME)
(LOCATION)
(DATE)

SUBMITTED BY
(NAME AND ADDRESS OF CONTRACTOR)
```
C. Provide a master index at the beginning of manual showing items included. Use plastic tab indexes for sections of manual. Each section shall contain the following information for equipment furnished under this contract:

1. Equipment and system warranties and guarantees.
2. Installation instructions.
3. Operating instructions.
5. Spare parts identification and ordering list.
6. Local service organization, address, contact and phone number.
7. Shop drawings with reviewed stamp of Design Professional and Contractor shall be included, if applicable, along with the items listed above.

D. Items to be included shall be those listed in shop drawing section.

1.14 TESTS AND DEMONSTRATIONS

A. All systems shall be tested by Contractor and placed in proper working order prior to demonstrating systems to Owner.

B. Contractor shall test the electrical grounding system resistance in accordance with Specification Section 26 05 26 – Grounding and Bonding for Electrical Systems and submit a report to Design Professional stating the results.

C. Prior to acceptance of the electrical installation, the Contractor shall demonstrate to the Owner, or his designated representatives, all essential features and functions of all systems installed, and shall instruct the Owner in the proper operation and maintenance of such systems. Owner instruction shall be provided for the following systems:

<table>
<thead>
<tr>
<th>Sections</th>
<th>Description</th>
<th>Hrs. on Site</th>
<th>Hrs. off Site</th>
<th>Presented By</th>
<th>Others Present</th>
<th>Remarks</th>
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<tr>
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<td>Contractor</td>
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<tr>
<td>26 24 13</td>
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<td>26 28 15</td>
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<tr>
<td>26 29 13</td>
<td>Motor Controls</td>
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<td>Contractor</td>
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<tr>
<td>26 24 19</td>
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<tr>
<td>26 09 23</td>
<td>Building Lighting Controls</td>
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<td>Manufacturer’s Representative</td>
<td>Contractor</td>
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<td>26 50 00</td>
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REMARKS:
1. Perform complete system test at time of instruction.
2. Refer to 26 0923 for training requirements.
3. Any unused hours shall be used at Owner’s discretion during the first year of occupancy.

D. Contractor shall submit to the Design Professional a certificate signed by the Owner stating the date, time, and persons instructed and that the instruction has been completed to the Owner’s satisfaction. An example of a certificate form is as follows:
CERTIFICATE OF SYSTEM DEMONSTRATION

This document is to certify that the contractor has demonstrated the hereafter listed systems to the Owner's representatives in accordance with the Contract documents and that the instruction has been completed to the Owner's satisfaction.

A. Project:

B. System(s):

C. Contractor's representatives giving instruction and demonstration:

Contractor: _____________________________

<table>
<thead>
<tr>
<th>NAMES</th>
<th>DATE</th>
<th>HOURS</th>
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<tbody>
<tr>
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</tbody>
</table>

D. Owner's representatives receiving instruction:

Owner: ________________________________

<table>
<thead>
<tr>
<th>NAMES</th>
<th>DATE</th>
<th>HOURS</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>

E. Acknowledgement of demonstration:

Contractor's Representative: _____________________________

signature

date

Owner's Representative: _____________________________

signature

date

ELECTRICAL GENERAL PROVISIONS  26 00 10 - 7
1.15 **SUBSTITUTIONS**

A. Refer to Divisions 00 and 01. Requests shall clearly describe the equipment for which approval is being requested. Include all data necessary to demonstrate that equipment's capacities, features and performance are equivalent between specified equipment and equipment for which approval is being requested. If the equipment is acceptable, Design Professional will approve it in an addendum. Design Professional will, under no circumstances, be required to prove that an item proposed for substitution is or is not of equal quality to the specified item.

B. Where substitutions are approved, Contractor assumes all responsibility for physical dimensions and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of the substitution.

1.16 **ACCEPTABLE MANUFACTURERS**

In most cases, equipment specifications are based on a specific manufacturer’s type, style, dimensional data, catalog number, etc. Listed with the base specification, either in the manual or on the plan schedules are acceptable manufacturers approved to bid products of equal quality. These manufacturers are encouraged to submit to Design Professional at least 8 days prior to the bid due date drawings and catalog numbers of products to be bid as equals.

Manufacturers, who do not submit prior to bidding, run the risk of having the product rejected at time of shop drawing submittal. Extra costs associated with replacing the rejected product shall be the responsibility of the Contractor and/or the manufacturer.

A. If Contractor chooses to use a manufacturer listed as an equal, it shall be his responsibility to assure that the manufacturer has complied with the requirements in ‘A’ above. Contractor shall assume all responsibility for physical dimensions, operating characteristics, and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of using the alternate manufacturer.

B. Where a model or catalog number is provided, it may not be inclusive of all product requirements. Refer to additional requirements provided on the plans or in the specifications as required. Similarly, there may be additional requirements included in the model or catalog number that are not specifically stated. These requirements shall also be met.

1.17 **GUARANTEE**

A. The entire electrical system including all sub-systems shall be guaranteed against defect in materials and installation for a minimum of one year from substantial completion or beneficial occupancy whichever occurs earlier. Any malfunctions which occur within the guarantee period shall be promptly corrected without cost to the Owner. This guarantee shall not limit or void any manufacturer's express or implied warranties.

1.18 **CHANGES IN THE WORK**

A. Refer to Divisions 00 and 01.

1.19 **COMPLETION**

A. Systems, at time of completion, shall be complete, efficiently operating, non-hazardous and ready for normal use by the Owner.

B. When all the electrical work is complete Contractor shall thoroughly clean all material and equipment installed as a part of this contract and leave all equipment and material in new condition.
C. Contractor shall clean up and remove from the site all debris, excess material and equipment left during the progress of this contract at job completion.

1.20 ACCESS DOORS

A. When the Electrical Contractor provides any equipment requiring periodic servicing which will be concealed by non-accessible architectural construction, the Electrical Contractor shall provide a flush access door. The access door shall be equal to a Karp DSC-211 Universal access door or Nystrom APWB or type for the specific construction involved.

B. Access doors in fire rated construction shall be fire rated and have U.L. label.

C. Construction:

1. Door and trim shall be 13 gauge steel, frames shall be 16 gauge steel.
2. Trim shall be of one piece construction.
3. Finish shall be prime coat of rust inhibitive baked grey enamel.
4. Hinges shall be concealed, offset, floating hinge.
5. Locks shall be flush, screwdriver operated with stainless steel cam-and-studs.

1.21 TEMPORARY UTILITIES

A. Refer to Specification Division 1 for specific requirements concerning temporary utilities.

1.22 CONCRETE EQUIPMENT PADS

A. Provide equipment housekeeping pads for all floor mounted equipment. Anchor equipment to concrete equipment pads according to equipment manufacturer’s recommendations.

1. Construct concrete bases of dimensions indicated or as required to be 4 inches larger in both directions than supported unit. Pads to be a minimum of 4” in height unless noted otherwise.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer’s setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts according to manufacturer’s recommendations and to elevations required for proper attachment to supported equipment.
6. Use 3000-psi compressive strength concrete with #3 rebar 12” O.C.

END OF SECTION 26 00 10
SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 26 00 10 - Electrical General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Contractor shall furnish all material, tools, labor and supervision necessary to install all wiring systems.

B. This section describes the basic materials and methods of installation for general wiring systems of 600 volts and less. Wiring for a higher voltage rating, if required, shall be as specified in other sections or called for on the drawings.

1.03 QUALITY ASSURANCE

A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wire, cable and connectors.

B. UL Compliance: Comply with UL standards pertaining to wire, cable and connectors.

C. UL Labels: Provide electrical wires, cables and connectors which have been UL-listed and labeled.

D. NEMA/ICEA Compliance: Comply with applicable portions of NEMA/Insulated Cable Engineers Association standards pertaining to materials, construction and testing of wire and cable.

E. ANSI/ASTM: Comply with applicable portions of ANSI/ASTM standards pertaining to construction of wire and cable.

F. The materials used for wiring systems shall be the products of a manufacturer regularly engaged in the manufacturing of the specified material.

PART 2 - PRODUCTS

2.01 WIRE AND CABLE

A. All wire and cable for power, lighting, control and signal circuits shall have copper conductors of not less than 98% conductivity and shall be insulated to 600 V. Conductor sizes #10 AWG and smaller shall be solid, conductor sizes #8 AWG and larger shall be stranded.

B. Minimum size conductors shall be #12 AWG for power and lighting.

C. Type of wire and cable for various applications shall be as follows:

1. Type THWN, or XHHW (75 deg. C) - use for branch circuits, panel and equipment feeders in wet and dry locations.

2. Type THHN, or XHHW (90 deg. C) - use for branch circuits, panel and equipment feeders in dry locations only. Use where lighting branch circuit conductors are routed through fluorescent fixture channels.
3. Type MTW, wet and dry locations - use for low voltage signal and control circuits operating at 25 volts or less.

4. Type UF - use where permitted by other sections or by the drawings for underground burial branch circuits.

D. For all vibration type installations (i.e. motors, etc), provide stranded type conductors.

2.02 CONDUCTOR COLOR CODING

A. Wiring systems shall be color coded. Conductor insulation shall be colored in sizes up through #8 AWG, conductors #6 AWG and larger shall have black insulation and shall be phase color coded with one-half inch band of colored tape at all junctions and terminations. Colors shall be assigned to each conductor as described below and carried throughout all main and branch circuit distribution. When necessary to use tape, use colored tape on black wire. Do not use colored tape on colored wire.

<table>
<thead>
<tr>
<th>Conductor Type</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 'A' Conductor</td>
<td>Black</td>
</tr>
<tr>
<td>Phase 'B' Conductor</td>
<td>Red</td>
</tr>
<tr>
<td>Phase 'C' Conductor</td>
<td>Blue</td>
</tr>
<tr>
<td>Neutral Conductor</td>
<td>White</td>
</tr>
<tr>
<td>Grounding Conductor</td>
<td>Green</td>
</tr>
</tbody>
</table>

2.03 CONNECTORS

A. In-line splices and taps for conductor sizes #8 AWG and smaller, use 3M Co. "Scotchlock" vinyl insulated spring connectors, or equal Ideal "wingnut" or Thomas & Betts. Wago wire nuts are also acceptable.

B. Connectors for conductors No. 6 and larger shall be of compression or split-bolt types, National Electric, Thomas & Betts, Blackburn or Burndy mechanical connectors. Fill connector voids with electrical insulation putty, follow with 3-M Scotch tape #33, minimum 2 layers.

PART 3 - EXECUTION

3.01 PREPARATION

A. Wire shall not be installed in the conduit system until the building is enclosed and masonry work is completed.

B. Conduit shall be swabbed free of moisture and debris prior to pulling in wiring. Pull mouse through conduits prior to pulling conductors.

3.02 INSTALLATION

A. All cable for major feeders shall be continuous from origin to termination, unless otherwise indicated.

B. Splices in branch circuit wires shall be made only in accessible junction boxes.
C. All power feeder cable shall be pulled with the use of approved pulling compound or powder. Compound must not deteriorate conductor or insulation.

D. Use pulling means, including fish tape, cable or rope which cannot damage raceway.

E. Install exposed cable, parallel and perpendicular to surfaces or exposed structural members and follow surface contours, where possible.

F. Keep conductor splices to a minimum.

G. The continuity of circuit conductors shall not be dependant on service connections such as lamp holders, receptacles, etc., where the removal of such devices would interrupt the continuity.

H. Provide separate green ground conductor throughout entire electrical system.

I. All branch circuits shall have dedicated neutrals.

3.03 FIELD QUALITY CONTROL

A. Prior to energizing system, test cable and wire for continuity of circuitry, and also for short circuits. Correct malfunctions when detected.

B. Subsequent to wire and cable hook-ups, energize circuitry and demonstrate functioning in accordance with requirements.
SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 26 00 10 - Electrical General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Extent of grounding work is indicated by drawings and shall comply with NEC.

B. Applications of grounding work in this section include the following:

1. Underground metal piping.
2. Underground metal water piping.
4. Metal building frames.
5. Grounding electrodes.
7. Grounding rods.
8. Separately derived systems.
9. Service equipment.
10. Enclosures.
11. Equipment.

C. Requirements of this section apply to electrical grounding work specified elsewhere in these specifications.

1.03 QUALITY ASSURANCE

A. NEC Compliance: Comply with NEC requirements as applicable to materials and installation of electrical grounding systems, associated equipment and wiring. Provide grounding products which are UL-listed and labeled.

B. UL Compliance: Comply with applicable requirements of UL Standards Nos. 467 and 869 pertaining to electrical grounding and bonding.

C. IEEE Compliance: Comply with applicable requirements of IEEE Standard 142 and 241 pertaining to electrical grounding.

PART 2 - PRODUCTS

2.01 GROUNDING SYSTEMS

A. Materials and Components

1. General: Except as otherwise indicated, provide electrical grounding systems indicated; with assembly of materials, including, but not limited to, cables/wires, connectors, terminals (solderless lugs), grounding rods/electrodes and plate electrodes, bonding jumper braid, surge arresters, and additional accessories needed for complete installation. Where more than one type unit meets indicated requirements, selection is Installer's option. Where materials or components are not indicated, provide products complying with NEC, UL, IEEE, and established industry standards for applications indicated.
2. Raceways: Provide raceways, and electrical boxes and fittings complying with Division 26, Section 26 05 33 – Raceway and Boxes for Electrical Systems.

3. Conductors: Unless otherwise indicated, provide electrical grounding conductors for grounding connections matching power supply wiring materials and sized according to NEC.

4. Bonding Plates, Connectors, Terminals and Clamps: Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by bonding plate, connector, terminal and clamp manufacturers for indicated applications.

B. Grounding Rods

1. Ground Rods:
   a. Solid copper, 3/4" dia. x 10' for service entrance.
   b. Solid copper, 5/8" dia. x 8' for other applications.

2. Electrical Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials and bonding straps as recommended by accessories manufacturers for type services indicated.

PART 3 - EXECUTION

3.01 INSTALLATION OF ELECTRICAL GROUNDING

A. General: Install electrical grounding systems where shown, in accordance with applicable portions of NEC, with NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products comply with requirements and serve intended functions.

B. Coordinate with other electrical work as necessary to interface installation of electrical grounding system with other work.

C. Install bonding jumpers with ground clamps on water meter piping to electrically bypass water meters.

D. Install clamp-on connectors only on thoroughly cleaned metal contact surfaces, to ensure electrical conductivity and circuit integrity.

E. Provide separate green ground conductor throughout entire electrical system sized as required by the NEC.

F. Isolated Grounding (IG) conductors shall be green colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

G. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
H. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

I. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building.

1. Install tinned-copper conductor not less than No. <Insert size> AWG for ground ring and for taps to building steel.
2. Bury ground ring not less than 24 inches from building foundation.

3.02 FIELD QUALITY CONTROL

A. Upon completion of installation of electrical grounding system, test ground resistance with earth test megger. Results shall be submitted to the Design Professional on a report form similar to that which follows:
# Earth Resistance Field Report

**PROJECT:**

**JOB NUMBER:** ______________________  **PAGE ________**

**OWNER:**

**DATE OF TEST:** ______________________  **CONDITIONS:** ______________________

**TEST LOCATION:** ______________________

**TEST METHODS:** ______________________

**TEST INSTRUMENT:** ______________________

**SOIL RESISTIVITY/TYP?):** ______________________

**COMMENTS (If applicable):**

---

**Testing Results:**

<table>
<thead>
<tr>
<th>Test No.</th>
<th>Description of systems tested</th>
<th>Earth Resistance Testing: Resistance to earth</th>
</tr>
</thead>
<tbody>
<tr>
<td>A)</td>
<td></td>
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<td>B)</td>
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<td>D)</td>
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<tr>
<td>E)</td>
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</tr>
</tbody>
</table>

**COMPLETED BY:** ______________________  **COPY TO:** ______________________

**COMPANY:** ______________________
B. Where tests show resistance to ground is over 3 ohms, take appropriate action to reduce resistance to 3 ohms or less by driving additional ground rods or by chemically treating soil encircling ground rod.

1. Retest to demonstrate compliance.

C. Medium Voltage System Grounds:

1. Test entire ground system for satisfactory continuity.

2. Subject completed system to megger test at each pull point, each building, and at switchyard to ensure ground does not exceed 5 ohms.

3. Tests may be accomplished by Triangulation Method.

END OF SECTION 26 05 26
SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 26 00 10 - Electrical General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Provide materials, labor and supervision as necessary to provide hangers and supports for conduit, fixtures and equipment.

1.03 QUALITY ASSURANCE

A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical supporting devices.

B. ANSI/NEMA Compliance: Comply with applicable requirements of ANSI/NEMA Std. Pub. No. FB 1, "Fittings and Supports for Conduit and Cable Assemblies".

C. NECA Compliance: Comply with National Electrical Contractors Association's "Standard of Installation" pertaining to anchors, fasteners, hangers, supports, and equipment mounting.

D. UL Compliance: Provide electrical components which are UL-listed and labeled.

PART 2 - PRODUCTS

2.01 MANUFACTURED SUPPORTING DEVICES

A. General: Provide supporting devices; complying with manufacturer's standard materials, design and construction in accordance with published product information, and as required for a complete installation; and as herein specified. Where more than one type of device meets indicated requirements, selection is Installer's option.

B. Conduit Cable Supports: Provide cable supports with insulating wedging plug for non-armored type electrical cables in risers; construct for rigid metal conduit; type wire as indicated; construct body of malleable iron casting with hot dip galvanized finish.

C. U-Channel Strut Systems: Provide U-channel strut system for supporting electrical equipment, 16-guage hot dip galvanized steel, of types and sizes indicated; construct with 9/16" dia. holes, 8" o.c. on top surface, with standard green finish, and with the following fittings which mate and match with U-channel:

1. Fixture hangers.
2. Channel hangers.
3. End caps.
4. Beam clamps.
5. Wiring stud.
6. Thinwall conduit clamps.
7. Rigid conduit clamps.
8. Conduit hangers.
D. Manufacturer: Subject to compliance with requirements, provide channel systems of one of the following:

1. B-Line Systems, Inc.
2. Thomas & Betts, Superstrut
3. Unistrut Div.; Tyco International
4. Globestrut

PART 3 - EXECUTION

3.01 INSTALLATION OF SUPPORTING DEVICES

A. Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements.

B. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

C. Conduit hangers and support devices shall be approved type for the method of supporting required. All hangers and supports shall have galvanized finish or other approved corrosion resistance finish. In general, hangers and supports shall be as follows:

1. Where single or multiple run of conduit is routed on surface of structure; use conduit clamps mounted on U-channel strut so as to maintain not less than 1" clearance between conduit and structure.

2. Where single run of conduit is suspended from overhead; use split ring conduit clamp suspended by 3/8" steel drop rod.

3. Where multiple parallel runs of conduit are suspended from overhead; use split ring conduit clamps uniformly spaced and supported on trapeze hangers fabricated of U-channel strut, suspended by not less than two steel drop rods.

4. Where circuit voltage is above 600 volts, conduit clamps shall be provided with insulating bushings of dielectric strength as required.

5. Where conduit is buried in concrete floor topping; anchor conduit to structural floor with one hole jiffy clamps.

6. Maximum hanger and support spacing shall be in accordance with NEC.

D. Hangers and supports shall be anchored to structure as follows:

1. Hangers and supports anchored to poured concrete, use malleable iron or steel concrete inserts attached to concrete forms.

2. Hangers or supports anchored to precast concrete, use self-drilling expansion shields. Expansion shields may be used where concrete inserts have been missed or additional support is required in poured concrete.

3. Hanger or supports anchored to structural steel, use beam clamps and/or steel channels as required by structural system.
4. Hangers or supports anchored to metal deck, use spring clips or approved welding pins. Maximum permissible load on each hanger shall not exceed 50 pounds.

5. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls.

6. Use sheet metal screws in sheet metal studs and wood screws in wood construction.

E. The following is not permitted:

1. Attaching supports and hangers to piping, ductwork, mechanical equipment, or conduit.

2. Use of powder-actuated anchors.

3. Drilling of structural steel members.

F. Fixtures on plastered or acoustical ceilings shall not be supported directly on ceiling tile. Provide metal bar hangers or U-channel strut attached to ceiling supports.

G. Where disconnect switches and panels cannot be mounted on wall, provide support racks fabricated of structural steel or U-channel strut.

H. Provide concrete bases and pads for transformers, switchgear, free standing panels, generators, outdoor lighting poles and other equipment requiring bases, except where drawings indicate that such bases and pads are to be furnished by the General Contractor. Furnish all equipment anchor bolts and installation for their proper and accurate location. All concrete work and reinforcing shall comply with General Specifications.

END OF SECTION 26 05 29
PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 26 00 10 - Electrical General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Contractor shall furnish all materials, tools labor and supervision necessary to fabricate and install complete conduit systems.

B. Conduit systems shall be provided for all wiring, except where the drawings or other sections of the specifications indicate that certain wiring may be installed in cable trays, surface raceway, underfloor raceway, wireways and/or auxiliary gutters.

C. Types of raceways in this section include the following:
   1. Rigid metal conduit.
   2. Intermediate metal conduit.
   3. Electrical metallic tubing.
   4. Flexible metal conduit.
   5. Liquid-tight flexible metal conduit.
   6. Rigid non-metallic conduit.
   7. MC cable.
   8. Surface metal raceways.

D. Provide factory painted red conduit for fire alarm system.

E. Contractor shall furnish all material, tools, labor and supervision necessary to install electrical boxes and fittings as required by drawings and specifications.

F. Types of electrical boxes and fittings in this section include the following:
   1. Outlet boxes.
   2. Junction boxes.
   3. Pull boxes.
   4. Gutters.
   5. Activation boxes.
   6. Handholes

G. Telecommunications Raceway Requirements:
   1. The term “telecommunications” includes all low voltage technology systems including voice and data, access control, video surveillance, intrusion detection, audio video, induction loop, paging, intercom, nurse call, school bell and/or clock systems. The term does not include fire alarm system, which is addressed separately in the plans and specifications.
   2. Contractor shall provide and install telecommunications boxes and conduits, including wall sleeves unless otherwise noted.
3. Below grade building entrance conduits within the building footprint shall be schedule 40 electrical PVC unless otherwise noted. Long sweep ninety degree elbows for under building footprint conduits shall be fiberglass sweeps with PVC schedule 40 conduit connectors built into the ends of the sweeps. Sweeps of 4” diameter shall be 36” minimum radius.

4. Below grade conduits for low voltage system cabling are not acceptable unless specifically directed. Below grade entrance conduits and floor boxes in slab on grade are exceptions to this rule.

5. Underground conduits outside the building footprint shall be continuous orange HDPE (high density polyethylene) with 1250 pound braided mule tape used as pull string unless otherwise noted. Round pull string or other rope is not acceptable for pulling due to risk of raceway damage. HDPE manufacturer approved water proof couplers shall be used for conduit type transition. HDPE to HDPE connection shall be hot fusion splice.

6. HDPE shall be minimum SDR 17 wall thickness for 2” diameter and smaller. The wall thickness shall be minimum SDR 11 for sizes larger than 2” diameter.

7. All below grade conduits shall be plugged at each end during construction to keep water, mud, rodents, etc., out.

8. All below grade entrance conduits shall be plugged on each end with removable mechanical plugs to keep water from entering the building for the life of the building. These plugs shall be installed inside the building above slab, and also at the first hand-hole outside the building (or where the conduits terminate underground). These plugs shall also seal around the utility entrance cables, including in and around all sub-ducts for a complete water tight seal. These mechanical plugs shall be as found on www.innerduct.com or engineer approved equivalent. Coordinate with the utility to determine size of cables for the plug inserts required. This work shall be completed before the Owner occupies the building.

9. All below grade exterior conduits shall have a tracer wire with adequate slack loop at each end for owner to conveniently connect and trace. All tracer wires shall protrude from closed hand holes so tracing may be accomplished without lifting the hand hole lid.

10. Interior building, above grade conduits and sleeves shall be EMT unless otherwise noted. PVC is never acceptable above grade.

11. All interior conduits shall have bushings installed during conduit installation. Completed individual installations shall have bushings installed same business day.

12. All interior conduits shall have pull strings, except sleeves which are less than 4’ long. EMT conduits shall receive standard round cable pull string (multi-strand plastic twine type).

13. Minimum interior conduit size for all information jacks (voice data cabling) shall be 1” unless otherwise noted.

14. Minimum interior conduit size for audiovisual shall be 1” unless otherwise noted. Junction (pull) boxes shall be added at a maximum of 100’ of raceway distance, and also for a maximum of 180 degrees of bend radius.

15. Minimum interior conduit size for video surveillance, intrusion detection, paging, intercom, nurse call, school bells and/or clock systems shall be 3/4” unless otherwise noted.

16. Access control system conduit sizes at the door location shall be per the access control detail found on the drawings. The conduit from the door location to the access control head end which contains all conductors needed for all access control functions at that door (may be individual conductors but is often one large composite cable) shall be minimum 3/4”.

17. Boxes for all low voltage systems in stud walls shall be metallic 5”x5”x2.875” with single gang mud ring unless otherwise noted.

18. Boxes in masonry walls shall be minimum 3.5” deep. single gang, unless otherwise noted.

19. Wiremold surface raceway for all low voltage systems shall be minimum V2400 unless noted otherwise.

20. Wiremold surface boxes for all low voltage shall be minimum 2.5” deep single gang, unless otherwise noted.
21. Conduits inside walls which feed the low voltage side of dual compartment Wiremold shall be minimum 1.25”
22. Contractor shall provide and install hand holes for cable pulling in buried raceway at a maximum interval of 500’.

1.03 QUALITY ASSURANCE
A. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.
B. UL Compliance and Labeling: Comply with provisions of UL safety standards pertaining to electrical raceway systems; and provide products and components which have been UL-listed and labeled.
C. NEC Compliance: Comply with requirements as applicable to construction and installation of raceway systems.
D. The materials used in the fabrication of the raceway system shall be products of a manufacturer regularly engaged in the manufacturing of the specified material.
E. NEC compliance: Comply with NEC as applicable to construction and installation of electrical wiring boxes and fittings.
F. UL Compliance: Provide electrical boxes and fittings which have been UL-listed and labeled.
G. ANSI/NEMA Standards Compliance: Comply with ANSI C 134.1 (NEMA Standards Pub No. OS 1) as applicable to sheet-steel outlet boxes, covers and box supports.

1.04 SUBMITTALS
A. Raceway Product Data: Submit manufacturer’s data including specifications, installation instructions and general recommendations, for each type of raceway listed below. Include data substantiating that materials comply with requirements for the following:
   1. MC Cable
   2. Surface Metal Raceway
B. Activation Box Product Data: Submit manufacturer’s data including specifications, installation instructions and general recommendations for each type of activation box required. Include data substantiating that units comply with requirements.
C. In-Ground Handhole Product Data: Submit manufacturer’s data including specifications, installation instructions and general recommendations for each type of handhole required. Include data substantiating that units comply with requirements.

PART 2 - PRODUCTS

2.01 RACEWAYS
A. General: Provide metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) for each service indicated. Where types and grades are not indicated, provide proper selection determined by Installer to fulfill wiring requirements, and comply with applicable portions of NEC for raceways. Conduit shall be used where concealed in permanent wall construction or in ceiling plenums. Surface raceway shall be used where exposed in finished regularly occupied areas.
B. Rigid Conduit: Full weight, threaded, rigid steel conduit, galvanized inside and out by hot dip or electro galvanized process. Additional protection by electrostatically applied baked coating. Thread protective caps and couplings. Use for all feeders larger than 2 1/2" in size.

C. Intermediate Metal Conduit (IMC): May be used as approved by code where rigid conduit is specified, except shall not be used for conduit buried in earth fill.

D. Electrical Metallic Tubing: Thin wall, electrically welded cold rolled steel conduit, galvanized inside and out by electro galvanized process. Baked clear elastic enamel coating in and out. Use for installations in stud walls, masonry walls, above suspended ceilings and where exposed. Size limited to 2 1/2" and smaller.

E. Flexible Metal Conduit: Formed of one continuous length of spirally wound electro galvanized steel strip. Use for final connections to all motor operated equipment such as unit heaters, fans, air handling units, pumps, generators, generator enclosures and connections to dry type transformer, connections from junction boxes to lighting fixtures in accessible ceiling, and for wiring within casework and millwork.

F. Liquidtight Flexible Metal Conduit: Formed of one continuous length of spirally wound electro galvanized steel strip, with water and oil tight neoprene jacket. Use for final connection to equipment listed in paragraph "D" above when located in wet areas.

G. PVC Conduit: Conduit shall be Carlon PV-Duit, Type 40, 90 deg.C. Conduit shall be composed of Polyvinyl Chloride and shall conform to NEMA Standards. Conduit, fittings and cement shall be produced by the same manufacturer. May be used where installed in earth fill or in poured concrete walls, columns, floors, or under concrete slab.


I. MC cable will not be allowed.

J. Surface Metal Raceways: Provide surface metal raceways of sizes and channels indicated on plans and constructed of steel or aluminum with covers. Finish with manufacturer's standard baked-on enamel paint or exposed metal as scheduled on drawings. Use where exposed in finished regularly occupied areas.

1. Manufacturer: Subject to compliance with requirements, the following manufacturers are acceptable:
   a. Wiremold (basis of design)
   b. Hubbell

2.02 CONDUIT FITTINGS

A. Rigid Conduit Fittings: Threaded, galvanized malleable iron or heavy steel, water and concrete tight. Grounding type nylon insulated bushings for connectors at cabinets, boxes and gutters.

B. Rigid Aluminum Conduit Fittings:

1. Fittings shall be standard threaded couplings, locknuts, bushings, and elbows. Material shall be malleable iron, steel or aluminum alloy. Iron or steel fittings shall be zinc or cadmium plated. Aluminum fittings shall not contain more than 0.4 percent copper.

2. Locknuts shall be of the bonding type with sharp edges for digging into the metal wall of an enclosure.
3. Bushings shall be of the metallic insulating type, and consist of an insulating insert molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.

4. Erickson-type couplings may be used to complete a conduit run where conduit is installed in concrete.

5. Sealing fittings shall be of the threaded cast iron type. Sealing fittings used to prevent passage of water vapor shall be of the continuous drain type.

6. Set screw fittings are not allowed.

C. Metallic Tubing Fittings: Compression type galvanized malleable iron or steel, water and concrete tight where exposed to wet locations or imbedded in concrete. Steel set screw type acceptable in all dry location applications.

D. Flexible Metal Conduit Fittings: External squeeze or set screw type galvanized malleable iron or steel with nylon insulated throats. Internal screw type fittings are not allowed.

E. Liquidtight Flexible Conduit Fittings: Galvanized malleable iron or steel, with watertight gaskets, "O" ring and retainer, and nylon insulated throats.

F. Condulet Fittings: Exposed conduit fittings shall be condulet type for all sharp turns, tees, etc.

G. Surface Metal Raceway Fittings: Provide types that match and mate to raceways provided.

H. Observe National Electrical Code requirements for insulated bushings on 1-1/4 inch and larger conduits. Double locknuts and fibre bushings with threads fully engaged are required. 1-1/4 inch and larger EMT connectors, if used, must also accommodate insulated bushings with threads fully engaged. T & B "Insuline" or Appleton insulated throat connectors are acceptable in lieu of separate bushings.

2.03 GUTTERS

A. General: Provide electrical raceways of types, grades, sizes and weights (wall thicknesses), number of channels, for each type of gutter indicated. Provide complete assembly of raceway including, but not necessarily limited to, couplings, offsets, elbows, expansion joints, adapters, hold down straps, end caps, and other components and accessories as needed for complete system. Where types and grades are not indicated, provide proper selection as determined by Installer to fulfill wiring requirements, and comply with applicable provisions of NEC for electrical raceways.

2.04 WALL OUTLET BOXES

A. General: Boxes shall be Raco, Steel City, Appleton or equal, catalog numbers based on Raco, unless otherwise indicated. In general, the type of boxes shall be as follows:

1. In Stud Walls: For single outlet use 4" square by 1-1/2" deep box #192. Boxes to be provided with raised covers of depth as required for thickness of wall materials.

2. In Masonry and Poured Concrete Walls: Use 3-3/4" high by 2-1/2" and/or 3-1/2" deep masonry boxes #691 through #699 and/or #960 through #969.

3. Surface Mounted Wall Outlets for conduit: Use 4" square by 1-1/2" deep box #192 with raised cover.

5. Suspended Ceiling: Use octagon boxes, depth as required for application, securely fastened to structure.

6. Poured Concrete Ceiling Slabs: Use octagon concrete rings with back plates.

7. Switch Outlets in Door Jambs: Use partition boxes #426 and #427 for single and two gang switches.

8. Outlets Installed Outdoors or in Wet Locations: Use Bell Product 200 Series outlet box.

2.05 ACTIVATION BOXES

A. Activation Boxes: Provide boxes as scheduled on the drawings.

B. Activation boxes shall be provided with barriers to separate high and low potential voltages.

C. Activation boxes shall be, complete with necessary gaskets, plates, spacers, mud caps, covers, fasteners, brackets and ancillary components appropriate for their installation. Follow manufacturer’s specific written instructions for each type of installation.

D. Furnish electrical outlets with duplex receptacles per specification Section 26 2726 – Wiring Devices.

E. Manufacturers: Subject to compliance with requirements, the following manufacturers are acceptable:

   a. Wiremold
   b. FSR Inc.
   c. Hubbell
   d. Steel City

2.06 PULL BOXES, JUNCTION BOXES & GUTTERS

A. Construction, sizes and installation of pull boxes, junction boxes and gutters shall comply with NEC, Article 314.

B. Pull and junction boxes not specifically described in NEC, Article 314, shall be fabricated of heavy gauge galvanized steel with screw or hinged covers, and equipped with corrosion resistant screws and hardware.

C. Pull and junction boxes for installation in poured concrete floors shall be flush type, cast iron, with watertight gasketed covers. Boxes for installation in floors with tile or carpet floor covering shall have recessed covers to accommodate the floor covering.

D. Gutters shall be constructed as a complete assembly of raceway including, but not necessarily limited to, couplings, offsets, elbows, expansion joints, adapters, hold down straps, end caps, and other components and accessories as needed for complete system. Gutters shall have hinged covers. Where types and grades are not indicated, provide proper selection as determined by Installer to fulfill wiring requirements.

E. Pull boxes, junction boxes and gutters for outdoor installation shall be raintight.
2.07 IN-GROUND HANDHOLES

A. UL or ETL Listed, polymer concrete construction, open bottom stackable. Quazite PG style or equal.
   1. Manufacturer: Subject to compliance with requirements, the following manufacturers are acceptable:
      a. Quazite
      b. HiLine
      c. Armorcast
      d. New Basis

B. All stainless steel hardware with minimum two fasteners per lid.

C. Extra heavy duty covers with non-skid surface, tier 22, 22,500 lb. vertical and 800 lbs/sq. ft. lateral design loads, unless noted otherwise.

D. Minimum size to be 11”x18”, unless noted otherwise. Larger handholes may be required at select locations.

PART 3 - EXECUTION

3.01 INSTALLATION OF RACEWAY

A. In general, all horizontal runs of branch circuit conduit shall be installed in ceiling plenum. Raceway for convenience outlets, wall mounted fixtures and other wall outlets shall be routed overhead and dropped through wall to the outlet. Branch circuit raceway shall not be installed in or below concrete floor slabs except where conditions will not permit the raceway to be installed overhead. Conduit shall be used where concealed in permanent wall construction or in ceiling plenums. Surface raceway shall be used where exposed in finished regularly occupied areas where walls are existing.

B. Feeder conduits to panelboards, motor control centers and other major loads may be installed in fill below concrete slabs on grade.

C. Conduits that are run in fill below concrete slabs on grade shall be installed so as not to interfere with welded wire mesh (wwm), vapor barrier, or concrete placement.

D. Generally, all conduit shall be concealed, except in crawl spaces, tunnels, shafts, mechanical equipment rooms, and at connection to surface panels and free standing equipment, and as otherwise noted.

E. Exposed conduit and conduit concealed in ceiling space shall be routed in lines parallel to building construction.

F. All conduit runs above suspended acoustical ceilings shall be routed so as not to interfere with tile panel removals with 4'0" to 6'0" flexible conduit drops from an independent junction box, accessible from below the ceiling, to ceiling mounted equipment.

G. Certain conduits are permitted to be embedded in structural concrete work, when permitted and coordinated with the Structural Engineer. Contractor shall cooperate with other contractors of their respective trades to affect the following:
   1. All reinforcing steel shall be securely anchored in place before installing conduit.
2. No steel reinforcing shall be displaced from plan dimensions without approval of the Design Professional.

3. Conduit and fittings shall not displace concrete in columns in excess of 4% of total cross-section area of column without approval of Design Professional.

4. Conduit shall not be placed closer than three (3) diameters on center.

5. Maximum size of embedded conduit or pipe shall not exceed 1/3 thickness of structural slab, 2/3 thickness of topping slab.

H. Minimum size conduit shall be 1/2" trade size except all home runs to panels shall be minimum 3/4". Minimum size surface raceway shall be V500. Where specified size is not called for on drawings or in the specifications, conduit shall be sized per NEC.

I. Install the conduit system mechanically and electrically continuous from outlet to outlet and to all cabinets, junction or pull boxes. Conduit shall enter and be secured to all cabinets and boxes in such a manner that all parts of the system will have electrical continuity.

J. Installation of PVC conduit shall comply with the NEC with regard to grounding.

K. PVC conduit shall not be installed above grade unless noted otherwise.

L. Support conduit raceway systems in accordance with requirements as set forth in the National Electric Code.

3.02 INSTALLATION OF BOXES AND FITTINGS

A. Install electrical boxes and fittings where indicated, complying with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

B. Coordinate installation of electrical boxes and fittings with wire/cable and raceway installation work.

3.03 OUTLET BOX INSTALLATION

A. Outlet boxes shall be installed for all fixtures, switches, receptacles and other devices.

B. Approximate locations of outlets are shown on the plans, but each outlet location as shown shall be checked by Contractor before installing the outlet box.

C. Wall boxes installed flush in common wall shall not be back-to-back or through-wall type. Boxes located on opposite sides of a common wall that are closely connected by conduit shall have the conduit openings plugged with duct seal.

D. Install boxes and conduit bodies in those locations to ensure ready accessibility of electrical wiring.

E. Outlet boxes shall be installed plumb and square with wall face and with front of box or cover located within 1/8" of face of finish wall. Boxes in masonry shall be set with bottom or top of the box tight to the masonry unit.
3.04 PULL BOX, JUNCTION BOX & GUTTER INSTALLATION

A. Install pull boxes, junction boxes and auxiliary wiring gutters where indicated on drawings and where required to facilitate installation of the wiring.

B. For concealed conduit, install boxes flush with ceiling or wall, with covers accessible and easily removable. Where flush boxes are installed in finish ceilings or walls, provide cover which shall exceed the box face dimensions by a sufficient amount to allow no gap between box and finished material.

C. Boxes shall not be located in finished, occupied rooms, without prior approval of Design Professional.

3.05 ACTIVATION BOX INSTALLATION

A. Install activation boxes flush with surrounding wall or floor surface, factor in lids and covers in addition to wall/floor finishes when setting boxes.

B. Coordinate raceway into boxes with Telecom and AV Contractors to limit number of bends and entry into appropriate sides of boxes.

C. Coordinate exact placement of boxes with Architectural details, do not scale drawings for locations.

3.06 IN-GROUND HANDHOLE INSTALLATION

A. Install all handholes flush with surrounding grade. Adjust handholes as required for finished grade.

B. Do not install handholes at low grade points. Install at locations to allow drainage away from box.

C. Provide 1” clean compacted fill beneath handholes for drainage. Clean fill shall extend 8” beyond the sides of the handhole enclosure, and a minimum of 12” deep.

END OF SECTION 26 05 33
PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 26 00 10 - Electrical General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Contractor shall provide identification for wiring systems and equipment as called for in this section.

B. Types of electrical identification specified in this section include the following:
   1. Conduit color banding.
   2. Buried cable warnings.
   3. Cable conductor identification.
   4. Operational instructions and warnings.
   5. Danger signs.

1.03 QUALITY ASSURANCE

A. UL Compliance: Comply with applicable portions of UL safety standards pertaining to electrical marking and labeling identification systems.

B. NEC Compliance: Comply with NEC as applicable to installation of identifying labels and markers for wiring and equipment.

PART 2 - PRODUCTS

2.01 ELECTRICAL IDENTIFICATION MATERIALS

A. General: Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is Installer's option, but provide single selection for each application.

B. Color-Coded Conduit Markers

1. General: Provide manufacturer's standard pre-printed, flexible or semi-rigid, permanent, plastic-sheet conduit markers, extending 360 degrees around conduits; designed for attachment to conduit by adhesive, adhesive lap joint of marker, matching adhesive plastic tape at each end of marker, or pretensioned snap-on. Except as otherwise indicated, provide lettering which indicates voltage, [panel and circuit] of conductor(s) in conduit.

2. Colors:
   a. 120/208 volt: gray/silver
   b. 277/480 volt: orange**
   c. Fire alarm: red*
   d. Division 27 systems: purple**
   e. Division 28 systems excluding fire alarm: purple**
f. Emergency/Critical: yellow**
g. Life Safety: green**

* Factory painted conduit required
**Factory painted conduit optional.

3. For conduits above ceilings, spray painting of boxes and portions of conduit is acceptable in lieu of banding. For exposed conduits in finished spaces, refer to architectural for paint to match room finish.

4. For branch circuits, mark panel name and circuit numbers on all junction/pull boxes.

C. Underground-Type Plastic Line Marker

1. General: Manufacturer's standard permanent, bright colored, continuous-printed plastic tape; not less than 6" wide x 4 mils thick intended for underground service. Provide tape with printing which most accurately indicates type of service of buried cable/conduit.

D. Cable/Conductor Identification Bands

1. General: Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type; either pre-numbered plastic coated type, or write-on type with clear plastic self-adhesive cover flap; numbered to show circuit identification.

E. Self-Adhesive Tape for Receptacle Circuit Identification

1. General: Provide self-adhesive or pressure-sensitive, pre-printed, flexible vinyl tape for panel name and circuit number.

F. Engraved Plastic-Laminate Signs

1. General: Provide engraving stock melamine plastic laminate, in sizes and thickness indicated, engraved with engraver's standard letter style of sizes and wording indicated, black and white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
   a. Thickness: 1/16", for units up to 20 sq. in. or 8" lengths; 1/8" for larger units.
   b. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate substrate.

PART 3 - EXECUTION

3.01 APPLICATION AND INSTALLATION

A. General Installation Requirements

1. Coordination: Where identification is to be applied to surfaces which require finish, install identification after completion of painting.

B. Conduit Identification

1. Conduit above accessible ceiling spaces shall be identified per 2.01 B.

2. Where electrical conduit is exposed in spaces with exposed mechanical piping which is identified by a color-coded method, apply color-coded identification on electrical conduit in a manner similar to piping identification.
3. Identify junction and pullboxes of systems with stencil lettering for panel and circuit numbers or system type.

C. Underground Cable/Conduit Identification

1. General: During back-filling/top-soiling of each exterior underground electrical, signal or communication cable or conduit, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in a common trench and do not exceed an overall width of 16", install a single line marker.

D. Cable/Conductor Identification

1. General: Apply cable/conductor identification on each cable and conductor in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present, except where another form of identification (such as color-coded conductors) is provided. Match identification with marking system used in panelboards, shop drawings, contract documents and similar previously established identification for project electrical work.

E. Operational Identification and Warnings

1. General: Wherever reasonably required to ensure safe and efficient operation and maintenance of electrical systems, and electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical facilities by unauthorized personnel, install self-adhesive plastic signs or similar equivalent identification, instruction or warnings on switches, outlets and other controls, devices and covers of electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for intended purposes.

F. Equipment/System Identification

1. General: Install engraved plastic-laminate sign on each major unit of electrical equipment in building; including central or master unit of each electrical system, unless unit is specified with its own self-explanatory identification. Except as otherwise indicated, provide single line of text, 1/2" high lettering on 1-1/2" high sign (2" high where 2 lines are required), white lettering in black field. Provide text matching terminology and numbering of the contract documents and shop drawings. Provide signs for each unit of the following categories of electrical work.

a. Panelboards, electrical cabinets and enclosures.
b. Access panel/doors to electrical facilities.
c. Major electrical switchgear.
d. Motor control centers, disconnects & starters.
e. Power transfer equipment.
f. Transformers.
g. Inverters.
h. Generators.

2. Install signs at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with fasteners, except use adhesive where fasteners should not or cannot penetrate the substrate.

END OF SECTION 26 05 53
SECTION 26 05 73 - SHORT-CIRCUIT/COORDINATION STUDY/ARC FLASH HAZARD ANALYSIS

PART 1 - GENERAL

1.01 SCOPE

A. The contractor shall furnish short-circuit, protective device coordination studies and arc flash analysis which shall be prepared by the equipment manufacturer.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

1.02 RELATED SECTIONS

1.03 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
5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems

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
5. ANSI C37.5 – Methods for Determining the RMS Value of a Sinusoidal Current Wave and Normal-Frequency Recovery Voltage, and for Simplified Calculation of Fault Currents

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
3. Submittals for review/approval

D. The short-circuit and protective device coordination studies shall be submitted to the design Design Professional prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the Design Professional may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.
1.04 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. No more than 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 will be provided without the section containing the computer printout of the short-circuit input and output data. Additional copies, where required, shall be provided on CD in PDF format.

B. A preview of the report shall be submitted to the Design Professional indicating short circuit calculations and arc flash levels prior to any electrical gear being released.

C. The report shall include the following sections:

1. One-line diagram showing protective device ampere ratings and associated designations, cable size & lengths, transformer kVA & voltage ratings, motor & generator kVA ratings, and switchgear/switchboard/panelboard designations
2. Descriptions, purpose, basis and scope of the study
3. Tabulations of the worst-case calculated short circuit duties as a percentage of the applied device rating (automatic transfer switches, circuit breakers, fuses, etc.); the short circuit duties shall be upward-adjusted for X/R ratios that are above the device design ratings
4. Protective device time versus current coordination curves with associated one line diagram identifying the plotted devices, tabulations of ANSI protective relay functions and adjustable circuit breaker trip unit settings
5. Fault study input data, case descriptions, and current calculations including a definition of terms and guide for interpretation of the computer printout
6. Incident energy and flash protection boundary calculations
7. Comments and recommendations for system improvements, where needed
8. Executive Summary including source of information and assumptions made

1.05 QUALIFICATIONS

A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies. The Registered Professional Electrical Engineer shall be a full-time employee of the Engineering Services Organization.

PART 2 - PRODUCTS

2.01 STUDIES

A. Contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer. By using the equipment manufacturer the study allows coordination of proper breakers, fuses, and current transformers. The coordination study shall begin with the utility company's feeder protective device and include all of the electrical protective devices down to and include the largest feeder circuit breaker and motor starter in the motor control centers and power distribution panelboards. The study shall also include variable frequency drives, harmonic filters, power factor correction equipment, transformers and protective devices associated with variable frequency drives, emergency and standby generators associated paralleling equipment and distribution switchgear.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.
2.02 DATA COLLECTION

A. Contractor shall furnish all field data as required by the power system studies. The Design Professional 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 eliminate unnecessary delays and 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 utility supplies, motors, and generators.

C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner or Contractor.

D. Include fault contribution of existing motors in the study, with motors < 50 hp grouped together. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

2.03 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standards 141, latest edition.

B. Transformer design impedances and standard X/R ratios shall be used when test values are not available.

C. Provide the following:
   1. Calculation methods and assumptions
   2. Selected base per unit quantities
   3. One-line diagram of the system being evaluated with available fault at each bus, and interrupting rating of devices noted
   4. Source impedance data, including electric utility system and motor fault contribution characteristics
   5. Typical calculations
   6. Tabulations of calculated quantities
   7. Results, conclusions, and recommendations

D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:
   1. Electric utility’s supply termination point
   2. Incoming switchgear
   3. Unit substation primary and secondary terminals
   4. Low voltage switchgear
   5. Motor control centers
   6. Standby generators and automatic transfer switches
   7. Branch circuit panelboards
   8. Other significant locations throughout the system

E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.

F. 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 bracing to withstand short-circuit stresses
3. Adequacy of transformer windings to withstand short-circuit stresses
4. Cable and busway sizes for ability to withstand short-circuit heating
5. Notify Owner in writing, of existing, circuit protective devices improperly rated for the calculated available fault current

G. In such cases where the short circuit study results in a requirement for greater AIC ratings than those listed in the contract documents, contact the design engineer for possible solutions. Current limiting fusible technology may be added to the electrical system to limit the amount of available fault current. The manufacturer providing the short circuit calculation shall recognize current limiting fusible technology and re-run the short circuit calculations.

2.04 PROTECTIVE DEVICE COORDINATION STUDY

A. Proposed protective device coordination time-current curves shall be graphically displayed on log-log scale paper.
B. Include on each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered.
C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.
D. Identify 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 curve sheets, where applicable:
   1. Electric utility’s protective device
   2. Medium voltage equipment 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 transformer withstand parameters
   6. Conductor damage curves
   7. Ground fault protective devices, as applicable
   8. Pertinent motor starting characteristics and motor damage points
   9. Pertinent generator short-circuit decrement curve and generator damage point
   10. Other system load protective devices for the largest branch circuit and the largest feeder circuit breaker in each motor control center
F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.05 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.
B. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Alternative methods shall be presented in the proposal.
C. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.

D. The Arc-Flash Hazard Analysis shall include all MV, 575v, & 480v locations and significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA.

E. Safe working distances shall be specified for calculated fault locations based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm$^2$.

F. The Arc Flash Hazard analysis shall include calculations for maximum and minimum contributions of fault current magnitude. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume a minimum motor load. Conversely, the maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

G. Arc flash computation shall include both line and load side of main breaker calculations, where necessary.

H. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2.

2.06 REPORT SECTIONS

A. Input Data:
   1. Utility three-phase and line-to-ground available contribution with associated X/R ratios
   2. Short-circuit reactance of rotating machines with associated X/R ratios
   3. Cable type, construction, size, # per phase, length, impedance and conduit type
   4. Bus duct type, size, length, and impedance
   5. Transformer primary & secondary voltages, winding configurations, kVA rating, impedance, and X/R ratio
   6. Reactor inductance and continuous ampere rating
   7. Aerial line type, construction, conductor spacing, size, # per phase, and length

B. Short-Circuit Data:
   1. Source fault impedance and generator contributions
   2. X to R ratios
   3. Asymmetry factors
   4. Motor contributions
   5. Short circuit kVA
   6. Symmetrical and asymmetrical fault currents

C. Recommended Protective Device Settings:
   1. Phase and Ground Relays:
      b. Current setting.
      c. Time setting.
      d. Instantaneous setting.
      e. Specialty non-overcurrent device settings.
      f. Recommendations on improved relaying systems, if applicable.
   2. Circuit Breakers:
      a. Adjustable pickups and time delays (long time, short time, ground).
      b. Adjustable time-current characteristic.
c. Adjustable instantaneous pickup.
d. Recommendations on improved trip systems, if applicable.

D. Incident energy and flash protection boundary calculations.

1. Arcing fault magnitude
2. Device clearing time
3. Duration of arc
4. Arc flash boundary
5. Working distance
6. Incident energy
7. Hazard Risk Category
8. Recommendations for arc flash energy reduction

PART 3 - EXECUTION

3.01 FIELD ADJUSTMENT

A. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the Contractor.

B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. Notify Owner in writing of any required major equipment modifications.

3.02 ARC FLASH WARNING LABELS

A. The vendor shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.

B. The label shall have an orange header with the wording, “WARNING, ARC FLASH HAZARD”, and shall include the following information:

1. Location designation
2. Nominal voltage
3. Flash protection boundary
4. Hazard risk category
5. Incident energy
6. Working distance
7. Engineering report number, revision number and issue date

C. Labels shall be machine printed, with no field markings

D. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.

1. For each 600, 480 and applicable 208 volt panelboards and disconnects, one arc flash label shall be provided
2. For each motor control center, one arc flash label shall be provided
3. For each low voltage switchboard, one arc flash label shall be provided
4. For each switchgear, one flash label shall be provided
5. For medium voltage switches one arc flash label shall be provided

E. Labels shall be field installed by the Contractor.
SECTION 26 09 23 - LIGHTING CONTROL SYSTEMS

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 26 00 10 - Electrical General Provisions are applicable to work required of this section.

B. Coordinate installation with 23 09 00 – Building Automation System (BAS).

1.02 DESCRIPTION OF WORK

A. Provide materials, equipment, labor and supervision necessary for a complete operational lighting control system as required by the drawings and this section.

B. This section applies to all work under this division. This shall include, but not necessarily be limited to, the following:

1. Furnish, install, and terminate all system equipment and cabling as applicable and per drawings.
2. Furnish and install any cabinets, racks and cable management as required and as indicated.
3. Furnish any other material required to form a complete and operational system.
4. Provide As-Built drawings per Division 0 and/or Division 1 specification.
5. Provide Owner training and testing documentation.
6. All elements of the construction shall be performed by workmen skilled in the particular craft involved, and regularly employed in that particular craft.
7. All work shall be performed in a neat, workmanlike manner in keeping with the highest standards of the craft.

1.03 QUALITY ASSURANCE

A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wiring devices.

B. UL Compliance and Labeling: Provide electrical wiring devices which have been UL-listed and labeled.

C. NEMA Compliance: Comply with NEMA standards for general- and specific-purpose wiring devices.


E. All Contractors shall familiarize themselves with all codes and standards applicable to their work. No extra compensation will be allowed for corrections or changes in the work required due to failure to comply with the applicable codes and standards. Where two or more codes or standards are in conflict, that requiring the highest order of workmanship shall take precedence, but such questions shall be referred to Design Professional for final decision.
1.04 SUBMITTALS

A. Submit manufacturer's product data literature for each lighting control component required. For occupancy sensors and related components, submit Manufacturer's device layout indicating recommended device placement, product data and project specific wiring diagrams. Submittals shall include the Sequence of Operation for each area of lighting control.

1.05 BUILDING COMMISSIONING

A. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative and the Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Division 01 for detailed commissioning requirements. Refer to Part 3 for manufacturer's commissioning requirements.

1.06 WARRANTY

A. The control system designated on the drawings and plans and herein specified shall be guaranteed to be free from original defects in both material and workmanship for a period of five (5) years. This warranty shall become effective starting the date of project substantial completion.

1.07 SYSTEM DESCRIPTION

A. System Architecture:

1. The lighting control system shall be a non-networked, distributed lighting control system. The system shall have no central monitoring, control or time functions. Each individual room or area shall have a standalone control system that is not dependent on a network for any reason including programming.

2. All system adjustments for time delays, high-level trim, low-level trim, fade times, blink warnings, photo sensor sensitivity, daylight setpoints, receptacle control time delays, vacancy mode, occupancy mode, etc. shall be programmable and adjustable without the use of a ladder.

B. Lighting control system for manual and automatic control of interior lighting systems.

1. Space Control – Provide occupancy/vacancy control with manual occupant input as noted on the lighting control sequence schedule.

2. Daylit Areas – All luminaires in the daylit zone shall be controlled separately from luminaires outside of daylit zones. Luminaires in the primary daylit zones shall be controlled separately from luminaires in secondary daylit zones.

3. Daytime setpoints for total ambient illumination (combined daylight and electric light) level that initiate dimming shall be programmed to be not less than 125% of the nighttime maintained designed illumination levels.

4. Provide smooth and continuous daylight dimming for areas marked on drawings. Daylighting control system will be designed to turn off electric lighting when daylight is at or above required lighting levels, only if system functions to turn fixtures back on at dimmed level, rather than turning full-on prior to dimming.
C. Additional controls.
   
   1. Provide 20A rated relays for control of receptacle loads as indicated on the drawings. Receptacle load relays are to operate whenever occupancy is detected regardless of manual switch input or photosensor input.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide lighting control systems of one of the following:
   
   1. WattStopper Digital Lighting Management – DLM
   2. Hubbell Building Automation – NX
   3. Cooper Greengate

2.02 SINGLE / DUAL RELAY WALL SWITCH OCCUPANCY SENSORS (STAND-ALONE)

A. Dual Technology: Manual-ON, Automatic-OFF dual technology (passive infrared and ultrasonic) wall switch occupancy sensor. Furnish the model which suits the electrical system parameters, and accommodates the square-foot coverage and wattage requirement for each area (and type of lighting) controlled. 120/277VAC rated.

2.03 WALL OR CEILING MOUNTED OCCUPANCY SENSOR SYSTEM

A. Description: Wall or ceiling mounted passive infrared (PIR), ultrasonic or dual technology digital (passive infrared and ultrasonic) occupancy sensor as indicated on the drawings. Furnish the system which accommodates the square-foot coverage requirements for each area controlled, utilizing room controllers, occupancy sensors and accessories which suit the lighting and electrical system parameters.

B. The manufacturer shall review electrical drawings and adjust sensor types and placement as required for proper covers based on the specific characteristics of the proposed sensor.

2.04 WALL SWITCHES AND DIMMERS

A. Description: Low voltage momentary pushbutton switches in 1, 2, 3, 4, and 5 button configuration compatible with wall plates with decorator opening. Wall switches shall include the following features:
   
   1. Engraving where indicated on the drawings.
   2. LED indicator lights indicating status.
   3. Dimmers shall indicate light level with multiple LEDs.

B. Switches and dimmers shall be able to function as noted below:
   
   1. Load and Scene button function may be reconfigured for individual buttons.
   2. Individual button function may be configured to Toggle, On only or Off only.
   3. Individual scenes may be locked to prevent unauthorized change.
2.05 ROOM CONTROLLERS

A. Room Controllers shall be provided to match the room lighting load and control requirements. The control units will include the following features:

1. Dual voltage (120/277 VAC, 60 Hz)

B. On/Off Room Controllers shall include:

1. One or two relay configuration

2. Relay controller listed for connection to receptacles, for occupancy-based control of plug loads within the space.
   a. One relay configuration only, rated at 20A, 120VAC.
   b. Automatic-ON/OFF configuration

C. On/Off/Dimming Room Controllers shall include:

1. One, two or three relay configuration

2. One 0-10 volt analog output per relay for control of compatible ballasts and LED drivers.

3. The following dimming attributes may be changed or selected via programming:
   a. Establish preset level for each load from 0-100%
   b. Set high and low trim for each load

4. Relay controller listed for connection to receptacles, for occupancy-based control of plug loads within the space.
   a. One relay configuration only, rated at 20A, 120VAC.
   b. Automatic-ON/OFF configuration

2.06 PHOTOSENSORS

A. Photosensors work with room controllers to provide automatic switching or dimming daylight harvesting capabilities for any load type connected to a room controller. Closed loop photosensors measure the ambient light in the space and control a single lighting zone. Open loop photosensors measure incoming daylight in the space, and are capable of controlling up to three lighting zones.

2.07 LIGHTING CONTROL RELAY PANELS

A. Provide lighting control panels in the locations and capacities as indicated on the plans and schedules. Each panel shall be of modular construction and consist of the following components:

1. Enclosure/Tub shall be NEMA 1, or as indicated on the plans.

2. Cover shall be configured for surface or flush wall mounting of the panel as indicated on the plans. The panel cover shall have a hinged and lockable door with restricted access to line voltage section of the panel.

3. Interior assembly shall be supplied as a factory assembled component specifically designed and listed for field installation. The interior construction shall provide total isolation of high voltage (Class 1) wiring from low voltage (Class 2) wiring within the assembled panel. The interior assembly shall include intelligence boards, power supply, and individually replaceable latching type relays. The panel interiors shall include the following features:
   a. Single-pole latching relays with modular plug-in design. Relays shall provide the following ratings and features:
      1) Electrical:
         a) 30 amp ballast at 277V
4. The clock shall have a backlight display, user keypad and shall provide 8 channels of time or astronomical control. Preprogrammed lighting control scenarios shall include: scheduled on/off, manual on/scheduled off, manual on/automatic switch sweep off, astronomical or photocell on/off and astronomical or photocell control with scheduled on/off. Time clock shall provide up to 42 holidays, automatic daylight savings adjustment, astronomical coordinates by major cities, and help screens. Program memory shall be non-volatile and clock shall retain time keeping during power outages for at least 48 hours.

5. Occupancy sensor and time control shall be integrated to allow occupancy sensor control after hours with hold on of lighting during occupancy scheduled time. During occupied time, control scenarios shall be selectable for time schedule of lighting on or occupancy sensor detection of lighting on initially and then hold on of lighting during occupied hours. Control shall provide selectable occupancy sensor blink warning prior to shut off and adjustable occupancy sensor time delay from the time clock keypad.

5. After-hour interior lighting shut off control shall provide a full duration override time of 1 to 240 minutes with a warning blink five minutes prior to shutting the lighting off. An impending shut off will be cancelled and the override period re-initialized through the operation of any assigned switch input.

6. After-hour interior lighting shut off control may be by line voltage power interrupt control to automatic control switches. The lighting control relay panel shall provide a warning blink signal to automatic control switches, thus allowing a five-minute delay prior to shutting off lighting. The lighting shut off event may be cancelled by pressing the automatic control switch push button. The lighting control panel time clock shall provide periodic lighting sweep signals to shut off automatic control switches.

B. Power supply shall be a multi-voltage transformer assembly with rated power to supply all electronics, occupancy sensors, switches, pilot lights, and photocells as necessary to meet the project requirements.

2.08 EMERGENCY LIGHTING

A. Emergency Lighting Control Unit – A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure, the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:

1. 120/277 volts, 50/60 Hz. 20 amp rating
2. Push to test button
3. Auxiliary contact for remote test or fire alarm system interface
4. Relays controlling 0-10V dimmed emergency lights shall include an auxiliary or integral relay device to open the control signal and force emergency lights to 100% light output.

PART 3 - EXECUTION

3.01 INSTALLATION OF WIRING DEVICES

A. Install components as indicated on the drawings and as called for below.

B. Low-voltage lighting control cables shall not share raceway or cable tray with telecommunications wiring. All cable shall be neatly routed and tie-wrapped to structural components. Excess wire shall be neatly coiled and secured to structure. Provide a 6’ coil of cable at each ceiling mounted device for ease of relocation if conflicts arise. Under no circumstances shall cable be supported by piping, conduit, ductwork, ceiling tile or ceiling support wires. Cable shall be neatly routed in line with building lines.
C. Where installed above accessible ceiling, all components shall be located in easily accessible areas. Any controller located in an area above a non-removable ceiling tile or where obstructed by piping or duct work shall be relocated. All locations shall be recorded on as-built drawings.

D. Low voltage lighting control cable shall not use the same conduit sleeves as fire alarm or telecommunications cable. Provide dedicated sleeves. Where installed within non-accessible permanent construction or in exposed areas, provide continuous raceway to accessible location.

E. It is the Contractor’s responsibility to determine the ceiling type for each space and provide accessories as required for installation of devices in ceiling.

F. Proper judgment must be exercised in executing the installation so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components.

G. It is the Contractor’s responsibility to arrange a pre-installation meeting with the manufacturer’s factory authorized representative, at the Owner’s facility, to verify placement of sensors and installation criteria.

H. Install the work of this Section in accordance with manufacturer’s printed instructions unless otherwise indicated.

I. Contractor is responsible to arrange a coordination meeting with the temperature controls contractor to coordinate BacNet or dry contact interface of the systems.

J. Calibrate all sensor time delays and sensitivity to provide proper detection of occupants and energy savings.
   1. Adjust time delay so that controlled area remains lighted for 15 minutes after occupant leaves area or as indicated in the Sequence of Operations.
   2. Adjust lighting system to provide maximum lighting levels as indicated on the drawings.

K. Provide 120V circuits as required for lighting control components.

3.02 FACTORY COMMISSIONING

A. Upon completion of the lighting control(s) installation, the lighting control system (all sensors and control equipment) shall be completely commissioned by the manufacturer’s factory authorized technician who will verify all adjustments and sensor placement to ensure a trouble-free occupancy-based lighting control system. The electrical contractor shall modify sensor locations and wiring as directed by the factory technician as required to achieve required functionality.

B. Upon completion of the lighting control system fine tuning the factory authorized technician shall provide the proper training to the Owner’s personnel in the adjustment and maintenance of the sensors.

C. Re-commissioning. After 90 days from Owner occupancy, review system performance with the Owner and recalibrate all sensor time delays and sensitivities to meet the Owner's requirements. Provide a detailed report of re-commissioning activity.

D. Provide written or computer-generated documentation on the commissioning of the system including room by room description. Report to include:
   1. Sensor parameters, time delays, sensitivities, and daylighting setpoints.
   2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
   3. Load Parameters (e.g. blink warning, etc.)
3.03 TRAINING

A. Provide three (3) two-hour training sessions for the Owner. The first training session is to be at the time of initial system startup. The second session is to be post-occupancy. The third session is to be used at Owner's discretion. The training is to include, but not limited to the following:

1. Detailed review of the system architecture, individual components, and wiring requirements.
2. System programming method included examples and demonstrations. These are to include adjustments for time delays, high-level trim, low-level trim, fade times, blink warnings, receptacle control time delays, vacancy mode, occupancy mode, etc.
3. Occupancy sensitivity adjustments for both PIR and ultrasonic setting, adjustments for an automatic learning mode and the ability to disconnect, and selection between PIR and Ultrasonic modes for dual technology devices.
4. System troubleshooting including types of component failures, associated system failure and repair/replacement and reprogramming procedures.

3.04 SPARE PARTS

A. Spare Parts: Provide the following list of spare equipment (for each type used) to Owner to match equipment used in project.

1. Occupancy Sensor, ceiling mounted – quantity: 2
2. Single Room 0 – 10V Controller – quantity: 2
4. Open-loop photosensor – quantity: 2
5. Closed-loop photosensor – quantity: 2
6. Control Cables – quantity: 100’
7. Digital Wall Switch, 2-button - Quantity: 2
8. Digital Wall Dimmer - Quantity: 2
9. Any specialty tool required for programming - Quantity: 1

END OF SECTION 26 09 23
SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 26 00 10 - Electrical General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Contractor shall furnish all equipment, materials, tools, labor and supervision necessary to install lighting panelboards and distribution panelboards as specified in this section and as called for on the drawings.

B. Types of panelboards and enclosures in this section include the following:
   1. Lighting and appliance panelboards.
   2. Power distribution panelboards.

1.03 QUALITY ASSURANCE

A. UL Compliance: Comply with applicable UL safety standards pertaining to panelboards and accessories, and enclosures; provide units which have been UL-listed and labeled.

B. NEC Compliance: Comply with NEC as applicable to installation of panelboards, cabinets and cutout boxes.


1.04 SUBMITTALS

A. Product Data: Submit manufacturer's data including specifications, installation instructions and general recommendations, for each type of panelboard required. Include data substantiating that units comply with requirements.

B. Shop Drawings: Submit dimensioned drawings of panelboards and enclosures showing accurately scaled layouts of enclosures and required individual panelboard devices, including but not necessarily limited to, circuit breakers, fusible switches, fuses, ground-fault circuit interrupters and accessories.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products of one of the following (specification based on Square D):
   1. General Electric
   2. Square D
   3. Cutler Hammer
2.02 PANELBOARDS

A. General: Except as otherwise indicated, provide panelboards, enclosures and components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials, design and construction in accordance with published product information; equip with number of unit panelboard devices as required for complete installation.

1. All Multi-Section Panels: Same dimensions.
2. Provide two keys for each panel.
3. Provide copper ground bar.
4. All panels shall have a designed short circuit rating label.

B. Lighting and Appliance Panelboards:

1. Panelboard bus structure and main lugs or main breakers shall have current ratings as shown on the panelboard schedule. Such ratings shall be established by heat rise tests, conducted in accordance with UL Standard 67. Bussing shall be distributed phase sequence type.

2. The bus assembly shall be enclosed in a steel cabinet. Wiring gutter space shall be in accordance with UL Standard 67 for panelboards. The rigidity and gauge of steel to comply with UL Standard 50 cabinets. Provisions for additional circuit breakers shall be such that field addition to connectors or mounting hardware will not be required to add circuit breakers to the panelboards.

3. If ground-fault interrupting breakers (GFI), switched neutral or other special types of breakers require additional pole spaces, size of panel shall be increased accordingly to give the scheduled numbers of poles for spare breakers and blank spaces.

4. Fronts shall include doors and have flush, stainless steel, cylinder tumbler-type locks with catches and spring-loaded door pulls. The flush lock shall not protrude beyond the front of the door. All panelboard locks shall be keyed alike. Fronts shall have adjustable indicating trim ring clamps which shall be completely concealed steel hinges. Fronts shall not be removable with door in the locked position. A circuitry directory frame and card with a clear plastic covering shall be provided on the inside of the door.

5. Terminals for feeder conductors to the panelboard mains and neutral shall be UL listed as suitable for conductor specified.

6. Each panelboard, as a complete unit, shall have a short circuit current rating equal to or greater than the integrated equipment rating shown on the panelboard schedule. Series connected interrupting ratings are not acceptable. This short circuit current rating shall be established by testing with the overcurrent devices mounted on the panelboard. The short circuit tests on the overcurrent devices and on the panelboard structure shall be made simultaneously by connecting the fault to each overcurrent device with the panelboard connected to its rated voltage source. Method of testing shall be per Underwriters Laboratories Standard UL 67. The source shall be capable of applying the specified panelboard short circuit current or greater. Testing of panelboard overcurrent devices for short circuit rating only while individually mounted is not acceptable. Also, testing of the bus structure by applying a fixed fault to the bus structure alone is not acceptable. Panelboards shall be marked with their maximum short circuit current rating at the supply voltage and shall be UL listed.

7. Provide two 1"C and three 3/4"C stubs out of all flush mounted panelboards to accessible ceiling space.

8. Panelboards shall have door-in-door covers.
C. Power Distribution Panelboards; Circuit Breaker Type:

1. Panelboards to be used for main circuit distribution and power circuit distribution shall be similar to lighting panelboards with the following additions:

   a. Cabinet doors over 48” long shall be equipped with three-point latch and vault lock. End walls shall be removable.

   b. Main lugs or main breakers shall be barriered on five sides. The barrier in front of the main lugs shall be hinged to a fixed part of the interior. The end of the bus structure opposite the mains shall be barriered.

   c. When required, panelboards shall be suitable for use as service equipment.

   d. Bus Bar: Copper.

D. Power Distribution Panelboards, fusible type:

1. Panelboards shall be dead front type, equipped with quick-make, quick-break fusible branch switches.

   a. Panelboard bus structure and main lugs or main switch shall have current ratings as shown on the panelboard schedule. The bus structure shall accommodate plug-on branch switches as indicated in the panelboard schedule without modifications to the bus assembly.

   b. All fusible branch switches shall be quick-make, quick-break with visible blades and dual horsepower ratings. Switch handles shall physically indicate "ON" and "OFF" positions. Switches shall be lockable only in the "OFF" position and accept three industrial type heavy duty padlocks. Switch covers and handles shall be interlocked to prevent opening in the "ON" position. A means shall be provided to permit authorized personnel to release the interlock for inspection purposes. A circuit identification cardholder shall be provided for each branch switch.

   c. Each panelboard, as a complete unit, shall have a short circuit current rating equal to or greater than the integrated equipment short circuit rating shown on the panelboard schedule or on the plans. Series connected interrupting ratings are not acceptable. This short circuit current rating shall be established by testing with the fusible switches mounted in the panelboard. Short circuit tests on the overcurrent devices and on the panelboard structure shall be made simultaneously by connecting the fault to each overcurrent device with the panelboard connected to its rated voltage source. Method of short circuit testing shall be per Underwriters Laboratories Standard UL 67. The source shall be capable of supplying the specified panelboard short circuit current or greater. Testing of panelboard overcurrent devices for short circuit rating only while individually mounted is not acceptable. Also, testing of the bus structure by applying a fixed fault to the bus structure alone is not acceptable. Panelboards shall be marked with their maximum short circuit rating at the supply voltage and shall be UL listed.

   d. Panelboards shall be UL listed for use on a system capable of delivering not more than 200,000 rms symmetrical amperes at 600 volts ac maximum when all branch switches are equipped with appropriately rated Class R, J, L or T fuses.
e. Panelboard assembly shall be enclosed in a steel cabinet. The rigidity and gauge of steel to be as specified in UL Standard 50 for cabinets. Wiring gutters shall be sized in accordance with UL Standard 67. Cabinets shall be equipped with a four-piece front without door and have concealed, self-adjusting trim clamps. Fronts shall be of full-finished steel with rust-inhibiting primer and baked enamel finish.

f. Bus Bar: Copper.

E. Load Centers:

1. Provide load center type panelboards as shown and scheduled on the drawings.

2. Branch circuit breaker ratings shall be of size and number as indicated on drawings. Load centers shall be plug-on type construction. All current carrying parts of the bus assembly shall be plated. Terminals for feeder conductors to main and branch neutral shall be UL listed as suitable for the type conductor specified. The load center bus assembly shall be enclosed in a steel cabinet. The size of the wiring gutters and gauge steel shall be in accordance with UL standards No. 67 for panelboards. Fronts shall include door and shall be provided with a directory for circuit identification. Load center boxes and fronts shall have rust-resisting phosphate treatment and baked enamel finish.

3. All branch breakers shall be plug-on type, toggle action with quick-make, quick-break mechanism. Trip indication shall be clearly shown by the breaker handle taking a position between ON and OFF when the breaker is tripped. All multi-pole breakers shall be single-operating handle, common-trip variety.

4. Integrated Interrupting Rating: Series rating not allowed.

2.03 CIRCUIT BREAKERS

A. General: Except as otherwise indicated, provide circuit breakers and ancillary components, of types, sizes, ratings and electrical characteristics indicated, which comply with manufacturer's standard design, materials, components, and construction in accordance with published product information, and as required for a complete installation.

B. Circuit Breakers - Branch Circuit Panelboards:

1. Branch circuit breakers up to 150 amperes shall be Square D Type QOB or equal. Breakers shall be bolt-on type toggle action with quick-make, quick-break mechanism. Trip indication shall be clearly shown by the breaker handle taking a position between on and off when the breaker is tripped. All multi-pole breakers shall be single-operated handle, internal common trip. Breakers having handle ties but not factory labeled "common trip" will be rejected. UL Class A ground fault circuit protection shall be provided on 120V AC branch circuits as specified on the plans or panelboard schedule. This protection shall be an integral part of the branch circuit breaker which also provides overload and short circuit protection for branch circuit wiring. Single pole 15 and 20 ampere circuit breakers shall be UL listed as "Switching Breakers" at 120V AC and carry the SWD marking. Tandem or "piggyback" breakers providing two circuits from one pole space are prohibited.

C. Circuit Breakers - Distribution Panelboards:

1. Molded case circuit breakers shall be rated 15 through 2500 amperes. Breakers covered under this specification may be applied in switchboards, panelboards, motor control centers, combination motor starter, busway plug-in units or individual enclosures.
2. Molded case circuit breakers shall have overcenter, trip-free, toggle-type operating mechanisms with quick-make, quick-break action and positive handle indication. Two and three-pole breakers shall be common trip. Each circuit breaker shall have a permanent trip unit containing individual thermal and magnetic trip elements in each pole. Units shall be constructed to accommodate the supply connection at either end. Operating handles shall assume a center position when tripped. All breakers shall be calibrated for operation in an ambient temperature of 40 deg. C. A button shall be provided on the cover for mechanically tripping the circuit breaker.

3. Breakers shall have removable lugs. Lugs shall be UL listed for copper/aluminum conductors. Breakers shall be UL listed for installation of mechanical screw type lugs.

2.04 FUSES

A. General: Except as otherwise indicated, provide fuses of types, sizes, ratings, and average time/current and peak let-through current characteristics indicated, which comply with manufacturer's standard design, materials, and construction in accordance with published product information, and with industry standards and configurations.

B. Main Service Feeders and Branch Circuits: For switch rating over 600 amperes: Hi-Cap, Type KRP-C with interrupting rating of 200,000 amperes RMS. For switch rating 600 amperes or less: Low peak current limiting fuses, Type LPN(S)-R, with interrupting rating of 200,000 amperes RMS.

C. Motors Above One (1) Horsepower: For fuse rating 600 amperes or less, dual element time delay, Type FRN(S)-R, with interrupting rating of 200,000 amperes RMS. Size fuses per Article 430 of the National Electric Code.

D. Motors One (1) Horsepower or Less: Single phase 150 volts or less, Fustat fuses for motor running protection sizes. Single phase or three phase over 150 volts, Fustron fuses for motor running protection, with interrupting rating of 100,000 RMS. Size fuses per Article 430 of the National Electric Code.

E. Fuses for all feeders, branch circuits, motors and other equipment shall be selected in types and ratings in accordance with NEC to provide a coordinated system of overcurrent protection, thus in case of a fault or harmful overload, only the fuses nearest the fault or overload will open.

F. Provide one spare set of three (3) of each size and type of fuse used on project.

2.05 SURGE PROTECTIVE DEVICE (SPD)

A. SPD shall meet UL 1449, 3rd Edition, Type 2 requirement.

B. SPD shall be integral to the panelboard.

C. SPD shall be have a minimum surge current capacity of 120,000A per phase, 60,000A per mode.

D. Provide 60A circuit breaker to connect SPD to bus.
PART 3 - EXECUTION

3.01 INSTALLATION OF PANELBOARDS

A. General: Install panelboards and enclosures where indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

B. Securely anchor panelboards to structure and make feeder and branch circuit connections as indicated in specifications and on the drawings.

C. Each panelboard directory shall be typewritten to identify the load fed by each circuit. Spare breakers and circuits to be left blank with circuit breaker in off position.

END OF SECTION 26 24 16
SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 26 00 10 - Electrical General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Provide materials, equipment, labor and supervision necessary to install wiring devices as required by the drawings and this section.

1.03 QUALITY ASSURANCE

A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wiring devices.

B. UL Compliance and Labeling: Provide electrical wiring devices which have been UL-listed and labeled.

C. NEMA Compliance: Comply with NEMA standards for general- and specific-purpose wiring devices.

1.04 SUBMITTALS

A. Submit manufacturer's name and product data literature for each type of wiring device required.

PART 2 - PRODUCTS

2.01 SWITCHES AND RECEPTACLES

A. All switches and receptacles shall be "specification grade", side and back wired, except where higher grade is called for on the plans. Acceptable manufacturers are as follows, with catalog numbers based on Hubbell, Inc.:

1. Hubbell, Inc.
2. Pass & Seymour
3. Leviton

B. Color of switches, receptacles and coverplates shall be determined at the time of shop drawing review.

C. Wall switches shall be as follows:

2. Double pole toggle light switch - 20 amp, 120-277 volt, #1222 series.

7. All switches serving emergency circuits shall be as specified in 2.01 above, except shall have "red" handles.

D. Receptacles shall be as follows:

1. Duplex receptacles - 2 pole, 3 wire grounding type, back and side wired, 20 amp, 125 volt, NEMA 5-20R (unless noted otherwise on drawings). Face material shall be thermoplastic. Acceptable manufacturer's catalog numbers: P&S 5362, Hubbell 5352, Leviton 5352. Wherever a duplex receptacle is shown outdoors, provide Hubbell 5362_WR or equivalent.

2. Receptacles for power and special purpose outlets shall have characteristics and NEMA configurations as per electrical symbols listed on drawings.

3. Ground fault interrupting receptacles (GFI) shall be duplex with test and reset buttons, equal to Hubbell GF5352 series.

4. Surge suppression outlets indicated as TVSS on drawings shall be equal to Hubbell 5352-IS.

5. Tamper resistant type duplex receptacles where required shall be 20 amp, 125 volt, NEMA 5-20R equal to Hubbell BR 20 series with the following additional requirements:

   a. Shall permit current to flow only while a standard plug is in the proper position in the receptacle.
   b. Screws exposed while the wall plates are in place shall be the tamperproof type.
   c. Shall be installed where indicated on plans.

6. Isolated ground type duplex receptacles shall be orange in color, equal to Hubbell IG 5362 (for 20 amp, 125 volt) or as designated on plans for special purpose ratings.

7. Combination isolated ground and surge suppression outlets shall be equal to Hubbell IG 5352IS.

8. All receptacles connected to emergency circuits shall be as specified in 2.01 above, except shall have "red" bodies.

2.02 WIRING DEVICE ACCESSORIES

A. Cover Plates:

1. Stainless steel, smooth metal, Type 302.

2. Provide plates for all switches, receptacles, TV outlets, other outlets and blank plates for unused outlets.

3. Plates for surface outlets shall be of the raised cover type utilizing 4" square boxes.

4. Outlets Installed Outdoors or in Wet Locations:

   a. Weather Proof Flip Cover ("WP"): Weatherproof device covers shall consist of cast metal cover plate and cap over each opening. The cap shall be permanently attached to the cover plate by a spring hinged flap. The weatherproof integrity shall not be affected when heavy duty specification or
hospital grade attachment plug caps are inserted. Cover plates on outlet boxes mounted flush in the wall shall be gasketed to the wall in a watertight manner.

1) Horizontally mounted devices shall have cover plate aligned for same mounting, equal to Hubbell CWP series.

2) Vertically mounted devices shall have cover plate aligned for same mounting, equal to Hubbell WP series.

b. Weather Proof Cord and Plug Cover ("WPD"): Intermatic WP1020 outdoor outlet covers. Covers to be made of clear, UV stabilized polycarbonate, hinged at the top with a securing tab at the bottom. Gaskets shall be provided to mount between outlet boxes and cover/base assemblies.

PART 3 - EXECUTION

3.01 INSTALLATION OF WIRING DEVICES

A. Install wiring devices as indicated on the drawings and as called for below.

B. In masonry walls, switches and receptacle heights shall be adjusted as required so outlets are at nearest mortar joint to specified height.

C. Where light switches are located adjacent to doors, they shall be installed on "knob" side of door, unless indicated otherwise.

D. Switched duplex receptacles shall be wired so that only the top receptacle is switched; the remaining receptacle shall be unswitched.

E. All GFI type receptacles shall be installed where GFI notation is shown on plans. No downstream protection of receptacles will be allowed from load side of other GFI type receptacles.

F. Prior to roughing-in outlet boxes, Contractor shall verify from general construction drawings, door swings, type of wall finishes and locations for counters and work benches.

END OF SECTION 26 27 26
SECTION 26 28 15 - MOTOR AND SERVICE DISCONNECTS

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 26 00 10 - Electrical General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. In general, disconnect switches are indicated on the drawings, and it shall be the Electrical Contractor's responsibility to furnish and install all disconnect switches for equipment and motors furnished by him, and for equipment and motors furnished by others.

1.03 QUALITY ASSURANCE

A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical motor and circuit disconnect switches.

B. UL Compliance and Labeling: Provide motor and circuit disconnect switches which have been UL-listed and labeled.


1.04 SUBMITTALS

A. Product Data: Submit manufacturer's data including specifications, installation instructions and general recommendations, for each type of motor and circuit disconnect switch required.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide products of one of the following manufacturers:

1. Bussman
2. General Electric
3. ITE
4. Square D Co.
5. Cutler Hammer

2.02 DISCONNECTS

A. All disconnects shall be heavy duty type unless noted otherwise.

B. Disconnects for fractional horsepower motors larger than 1/2 horsepower, for integral horsepower motors, and for equipment of similar capacity shall break all ungrounded conductors and shall be quick-make, quick-break with interlocking covers.

C. Disconnects installed indoors shall have NEMA 1 enclosures, disconnects installed outdoors or in wet locations shall have raintight NEMA 3R enclosures.

D. All disconnects shall be of the fuse type, except where drawings indicate non-fuse type (N.F.).
PART 3 - EXECUTION

3.01 INSTALLATION OF MOTOR AND CIRCUIT DISCONNECT SWITCHES

A. Install motor and circuit disconnect switches where indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products fulfill requirements.

B. Install disconnect switches used with motor-driven appliances, and motors and controllers within sight of controller position unless otherwise indicated.

END OF SECTION 26 28 15
SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 26 00 10 - Electrical General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Provide circuit breakers, fuses and motor overload relays and install in disconnect switches and motor starters as required for proper overcurrent protection for service feeders, branch feeders, branch circuits, motors, transformers and other equipment requiring protection.

B. Overcurrent protection shall be provided for each conductor and all equipment to open the circuit if the current reaches a value that will cause an excessive or dangerous temperature in conductors or conductor insulation. Circuit breakers shall have frame and trip ratings as scheduled on drawings.

C. Types of overcurrent protective devices in this section include the following:
   1. Circuit breakers
   2. Fuses
   3. Overload relays

1.03 QUALITY ASSURANCE

A. NEC Compliance: Comply with NEC requirements as applicable to construction and installation of overcurrent protective devices.

B. UL Compliance: Comply with applicable requirements of UL 489, "Molded-Case Circuit Breakers and Circuit Breaker Enclosures", and UL 198D, "High-Interrupting- Capacity Class K Fuses". Provide overcurrent protective devices which are UL listed and labeled.

C. NEMA Compliance: Comply with applicable requirements of NEMA Std. Pub. Nos. AB 1, AB 2, and SG 3 pertaining to molded-case and low voltage power-type circuit breakers.

D. ANSI Compliance: Comply with applicable requirements of ANSI C97.1 pertaining to low voltage cartridge fuses.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's data on overcurrent protective devices, including: amperes, voltages and current ratings, interrupting ratings, current limitations, internal inductive and non-inductive loads, time-current trip characteristic curves, and mounting requirements.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide products of one of the following:
   1. Circuit Breakers
      a. General Electric Co.
b. Square D Co.
c. Cutler Hammer

2. Fuses
   b. CEFCO
   c. Gould Shawmut
d. Littelfuse

B. All similar products shall be of the same manufacturer.

2.02 CIRCUIT BREAKERS

A. General: Except as otherwise indicated, provide circuit breakers and ancillary components, of types, sizes, ratings and electrical characteristics indicated, which comply with manufacturer's standard design, materials, components, and construction in accordance with published product information, and as required for a complete installation.

B. Circuit Breakers - Branch Circuit Panelboards:

1. Branch circuit breakers up to 150 amperes shall be Square D Type QOB or equal. Breakers shall be bolt-on type toggle action with quick-make, quick-break mechanism. Trip indication shall be clearly shown by the breaker handle taking a position between on and off when the breaker is tripped. All multi-pole breakers shall be single-operated handle, internal common trip. Breakers having handle ties but not factory labeled "common trip" will be rejected. UL Class A ground fault circuit protection shall be provided on 120V AC branch circuits as specified on the plans or panelboard schedule. This protection shall be an integral part of the branch circuit breaker which also provides overload and short circuit protection for branch circuit wiring. Single pole 15 and 20 ampere circuit breakers shall be UL listed as "Switching Breakers" at 120V AC and carry the SWD marking. Tandem or "piggyback" breakers providing two circuits from one pole space are prohibited.

C. Circuit Breakers - Distribution Panelboards:

1. Molded case circuit breakers shall be rated 15 through 2500 amperes. Breakers covered under this specification may be applied in switchboards, panelboards, motor control centers, combination motor starter, busway plug-in units or individual enclosures.

2. Molded case circuit breakers shall have overcenter, trip-free, toggle-type operating mechanisms with quick-make, quick-break action and positive handle indication. Two and three-pole breakers shall be common trip. Each circuit breaker shall have a permanent trip unit containing individual thermal and magnetic trip elements in each pole. Units shall be constructed to accommodate the supply connection at either end. Operating handles shall assume a center position when tripped. All breakers shall be calibrated for operation in an ambient temperature of 40 deg. C. A button shall be provided on the cover for mechanically tripping the circuit breaker.

3. Breakers shall have removable lugs. Lugs shall be UL listed for copper/aluminum conductors. Breakers shall be UL listed for installation of mechanical screw type lugs.
2.03 FUSES

A. General: Except as otherwise indicated, provide fuses of types, sizes, ratings, and average time/current and peak let-through current characteristics indicated, which comply with manufacturer's standard design, materials, and construction in accordance with published product information, and with industry standards and configurations.

B. Main Service Feeders and Branch Circuits: For switch rating over 600 amperes: Hi-Cap, Type KRP-C with interrupting rating of 200,000 amperes RMS. For switch rating 600 amperes or less: Low peak current limiting fuses, Type LPN(S)-R, with interrupting rating of 200,000 amperes RMS.

C. Motors Above One (1) Horsepower: For fuse rating 600 amperes or less, dual element time delay, Type FRN(S)-R, with interrupting rating of 200,000 amperes RMS. Size fuses per Article 430 of the National Electric Code.

D. Motors One (1) Horsepower or Less: Single phase 150 volts or less, Fustat fuses for motor running protection sizes. Single phase or three phase over 150 volts, Fustron fuses for motor running protection, with interrupting rating of 100,000 RMS. Size fuses per Article 430 of the National Electric Code.

E. Fuses for all feeders, branch circuits, motors and other equipment shall be selected in types and ratings in accordance with NEC to provide a coordinated system of overcurrent protection, thus in case of a fault or harmful overload, only the fuses nearest the fault or overload will open.

F. Provide one spare set of three (3) of each size and type of fuse used on project.

PART 3 - EXECUTION

3.01 INSTALLATION OF OVERCURRENT PROTECTIVE DEVICES

A. Install overcurrent protective devices as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to ensure that protective devices comply with requirements. Comply with NEC and NEMA standards for installation of overcurrent protective devices.

B. Coordinate with other work, including electrical wiring work, as necessary to interface installation of overcurrent protective devices with other work.

END OF SECTION 26 28 16
PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 26 00 10 - Electrical General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Extent of motor starter work is indicated by drawings and schedules.

B. Types of motor starters in this section include the following:

- Magnetic
- Combination
- Reversing
- Fractional HP Manual
- Integral HP Manual
- Solid-state reduced voltage
- Wye-delta reduced voltage
- Auto transformer reduced voltage

1.03 QUALITY ASSURANCE

A. NEC Compliance: Comply with NEC as applicable to wiring methods, construction and installation of motor starters.

B. UL Compliance and Labeling: Comply with applicable requirements of UL 508, "Electric Industrial Control Equipment", pertaining to electrical motor starters. Provide units which have been UL-listed and labeled.

C. NEMA Compliance: Comply with applicable portions of NEMA standards pertaining to motor controllers/starters and enclosures.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's data on motor starters.

B. Shop Drawings: Submit dimensioned drawings of motor starters showing accurately scaled equipment layouts and spatial relationship to associated motors, and connections to electrical power panels and feeders.

1. Include electrical ratings, dimensions, mounting, material, running overcurrent protection, branch circuit overcurrent protection, wiring diagrams, starting characteristics, interlocking, and accessories.
PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide products of one of the following (for each type and rating of motor starter):

1. Square D
2. Cutler Hammer
3. General Electric
4. Allen-Bradley

2.02 MOTOR STARTERS

A. General: Except as otherwise indicated, provide motor starters and ancillary components which comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation. Where more than one type of equipment meets indicated requirements, selection is Installer's option.

B. Magnetic Starters with Solid State Overloads: Provide full voltage alternating current magnetic starters of types, ratings and electrical characteristics indicated; equip with solid state overload relays. Trip current rating will be established by selection of overload relay and shall be adjustable (3 to 1 current range). The overload shall be self-powered, provide phase loss and phase unbalance protection, and be ambient insensitive. It will also be available in Trip Class 10 or 20 and have a mechanical test function. Electrical interlocks as required for the control sequences indicated; enclosure of NEMA type suitable for environmental conditions where installed; control transformer within each enclosure where required to provide 120 volt control voltage; manual reset on the door of each enclosure; selector switches, pilot lights, push buttons and other devices and accessories as shown on the drawings or otherwise required.

C. Combination Starters: Provide full-voltage alternating-current combination starters, consisting of starters and disconnect switches mounted in common enclosures of types, sizes, ratings, and NEMA sizes indicated. Equip starters with features as described in B above. Operating handle for disconnect switch mechanism shall indicate and control switch position with enclosure door open or closed; capable of being locked in OFF position and mechanically interlocked to prevent opening unless switch within the enclosure is open. Construct and mount starters and disconnect switches in single NEMA type enclosure suitable for environmental conditions where installed.

D. Reversing Starters: Provide alternating current combination reversing starters consisting of equipment with features as described in B and C above. Equip starters with electrical and mechanical interlocks to prevent both forward and reversing contactors closing simultaneously.

E. Fractional HP Manual Starters: Provide manual single-phase fractional HP motor starters, of types, ratings and electrical characteristics indicated; equip with thermal overload relay of the melting alloy type for protection of 120 VAC motors of 1/2 HP and less. Provide starters with quick-make, quick-break trip free toggle mechanisms, green pilot lights, and with toggle operated handle with handle lock-off; mount starter in NEMA type enclosure suitable for environmental conditions where installed.

F. Integral HP Manual Starters: Provide manual motor starters for on-off operation of small single-phase and poly-phase motors up to 10 HP, of types, ratings and electrical characteristics indicated. Equip with thermal overload relays of the melting alloy type sized per manufacturer's recommendations for proper protection of motor; green pilot light; and electrical interlocks as required for the control sequences indicated.
G. Solid-State Reduced Voltage Starters: Provide solid-state reduced voltage starters for use with 3-phase squirrel cage induction motors, of types, sizes, ratings and electrical characteristics indicated; construct with silicon controlled rectifiers (SCR'S) to control motor voltage during acceleration. Equip starter with circuit breaker, and with closed-loop feedback system to maintain motor acceleration at constant rate. Mount starter in NEMA type enclosure suitable for the environmental conditions where installed.

H. Wye-Delta Starters: Provide wye-delta starters, of types, sizes, ratings, electrical characteristics and NEMA sizes indicated. Construct starters with resistor type closed-circuit transition wiring, including three 3-pole contactors, adjustable pneumatic timer, and 3-pole overload protection relay. Equip with START-STOP push button for control. Mount starter with NEMA type enclosure suitable for environmental conditions where installed.

I. Autotransformer Reduced Voltage Starters: Provide autotransformer type reduced voltage starters, of sizes, ratings, electrical characteristics and NEMA size indicated, with closed-circuit transition feature. Construct starters with three 3-pole contactors, 3-phase starting autotransformer, adjustable pneumatic timer, and 3-pole block type overload relay. Construct autotransformer with voltage taps at 65% and 80% of full line voltage, and with a thermal overload protection device on each phase to protect against overheating. Provide duty cycle of 15 second operation out of each 4 minutes for one hour followed by a rest period of two hours. Mount starter with NEMA type enclosure suitable for environmental conditions where installed.

PART 3 - EXECUTION

3.01 INSTALLATION OF MOTOR STARTERS

A. Install motor starters as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

B. Coordinate with other work including motor and electrical wiring/cabling work, as necessary to interface installation of motor starters with other work.

C. Install fuses in fusible disconnects.

3.02 ADJUST AND CLEAN

A. Inspect operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movement.

B. Touch-up scratched or marred surfaces to match original finish.

3.03 FIELD QUALITY CONTROL

A. Subsequent to wire/cable hook-up, energize motor starters and demonstrate functioning of equipment in accordance with requirements; where necessary correct malfunctioning units.

END OF SECTION 26 29 13
SECTION 26 29 23 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.01 RELATED WORK
A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 26 00 10 - Electrical General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK
A. Variable speed AC motor controllers and all power wiring. Control wiring and system control components by others.

B. Variable speed AC motor controllers shall be of the "Variable/Adjustable Frequency" or "Inverter" type drives based on solid state electronics. The adjustable frequency AC drive shall convert 3 phase, 60 Hertz input power to an adjustable AC frequency and voltage 3 phase output for controlling the speed of any NEMA MG 1 Design B squirrel cage induction motor. The adjustable frequency drive shall have the following basic design:

1. Converter - Converter shall consist of a modular assembly consisting of a diode rectifier and capacitor assembly which will first convert, then filter and maintain a fixed DC voltage source from the fixed voltage and frequency input.

2. Inverter - Inverter shall consist of a modular assembly consisting of power semiconductors for generation of a sine-coded pulse width modulated (PWM) output waveform.

3. Regulator - Regulator shall consist of a modular assembly. The regulator shall be fully digital and incorporate a microprocessor to control all inverter, converter, and external interface functions.

4. Interface - Interface shall consist of terminal strips for all input and output signals.

C. All control instrument components shall be electronic and of industrial control quality and furnished with variable speed motor controllers complete as outlined in these specifications and drawings.

D. The variable speed motor controller supplier shall provide all necessary factory and/or field labor for complete calibration and adjustment of the adjustable frequency drives and control components, and shall be responsible for setting all control set points, operating sequences, and alarming systems within the specified control systems to produce the overall system performance as specified.

1.03 SUBMITTALS
A. Submittal data shall include but not be limited to drawings and/or catalog cuts giving physical dimensions, wiring diagrams (control and power diagrams), construction materials, capacities, ratings, control sequencing, manufacturers recommended installation instructions, and any other pertinent information.

B. Provide operating and maintenance manuals.
C. Provide recommended spare parts list and prices. Also, the address of the manufacturer's closest parts stocking location shall be provided.

D. Include manufacturer's standard product warranty (for not less than a one year period) for replacement of materials and equipment.

1.04 START-UP SERVICE

A. The supplier of the variable speed motor controller shall have a factory trained service representative provide start up service and commissioning.

B. Contractor shall coordinate controller parameters with other contractors.

1.05 TRAINING

A. The supplier of the variable speed motor controller shall have a factory trained service representative provide eight (8) hours of on-site training for the Owner's personnel advising of the proper methods of maintenance and operation of the controller.

B. Additional training time as deemed necessary by the Owner's authorized representative may be obtained from the supplier on a negotiated basis with the Owner.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. The variable speed AC motor controllers shall meet all requirements of this section. Subject to compliance with requirements, acceptable manufacturers are as follows:

1. Square D
2. Cutler Hammer
3. General Electric

2.02 CONTROLLERS

A. General: For the purpose of this Part, the word "controller" shall mean variable speed AC motor controller.

B. The controller shall be mounted in a NEMA ventilated enclosure appropriate for environment. The enclosure size shall be adequate to dissipate the heat generated by the controller within the limits of the specified environmental operating conditions. The door shall be hinged, secured with latch. "Bolt-on" doors are not acceptable.

C. Ambient service temperature rating shall be from 0°C to 40°C for normal operating conditions. The controller shall operate at less than 90% relative humidity non-condensing. The controller shall operate at an altitude less than 1000 meters (3300 feet) above sea level.

D. Input power rating shall be 3 Phase, voltage as scheduled per drawings +/- 10%, 60 Hertz +/- 3%.

E. The controller shall have a door interlocked incoming AC disconnect with external operator handle which is capable of being locked in the "off" position. The disconnect shall shutdown all input power to both the drive and the bypass circuitry, where applicable.

F. The controller shall have the input fused internally with standard fuses.
G. Controller shall have an output frequency range of 5 to 120 Hertz. The frequency regulation shall be +/- .5% of maximum frequency.

H. The controller shall provide thermal overload relays on the inverter output for motor protection for each motor controlled.

I. The controller shall maintain power factor to .95 or greater throughout its speed range for each motor controlled.

J. The controller shall have as a minimum the following protective features:
   1. Short circuit protection.
   2. Under/over voltage protection.
   3. Automatic restarting after a power outage or momentary overvoltage.
   4. Ground fault protection, but there shall be no automatic restart into ground fault.
   5. Overcurrent protection.
   7. Over temperature protection.
   8. Start into rotating motor protection. The controller shall catch a spinning load without tripping.

K. The controller shall be rated for 100% continuous current. The controller shall be capable of providing 110% of rated current for a minimum period of one minute. The controller shall have adjustable current limit. The controller shall have current limited stall prevention during acceleration, deceleration, and run conditions.

L. The controller shall have process follower inputs for 4-20 mA. Provide bias and gain adjustments for the follower.

M. The controller shall provide adjustable linear acceleration and deceleration control, each separately adjustable. The ramp time shall be adjustable from 0.1 to 30 seconds. Longer ramp times shall be optionally available.

N. The controller shall provide maximum and minimum frequency control, each separately adjustable.

O. The controller shall have internal manually operated bypass circuitry for direct line motor operation. Provide an inverter/line selector switch on the front panel to transfer the motor from the adjustable speed drive to the power line, or from the line to the inverter at zero speed. Motor protection and other safety devices shall be operative in both inverter and line modes.

P. The controller shall have a motor contactor at the inverter output. The controller shall also have three contactor bypasses.

Q. Fault indicators shall indicate the following fault conditions:
   1. Overcurrent.
   2. Short circuit.
   3. Undervoltage.
   4. Overvoltage.
   5. Overtemperature.
   6. Regulator function error.
   7. Ground fault.
In addition to the fault indicators, the controller shall provide normally open Form C fault contacts to allow remote monitoring of drive conditions.

R. The controller shall have as a minimum the following operator controls mounted on the front panel:

1. Manual/Auto selector.
2. Start/Stop switch.
3. Inverter/Line switch.
4. Speed potentiometer.
5. Fault reset.
6. Speed Indicator.

S. The controller shall provide adjustable carrier frequency.

T. The controller shall have an internal line reactor and EMI/RFI filters.

**PART 3 - EXECUTION**

**3.01 INSTALLATION OF CONTROLLERS**

A. Install controllers as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

B. Coordinate with other work including motor and HVAC controls work, as necessary to interface installation of controllers with other work.

C. The controllers shall be mounted and installed on the mechanical equipment room walls whenever possible. When the controllers cannot be wall mounted, the controllers shall be installed on four inch housekeeping pads. Installation of units directly on the floor will not be acceptable.

D. Each controller shall have a dedicated raceway for the input power feeder, output power feeder and controls. Raceway shall be separated by at least 6” from other controller feeders and controls raceway.

**3.02 OPERATION**

A. Manual/Auto System Operation

1. Selector switch in MANUAL mode - operation shall be from the door mounted potentiometer and the system shall be operable from 0-100% on the potentiometer operating between the minimum and maximum speeds as set in the inverter.

2. Selector switch in AUTO mode - operation shall be from the input follower signal, with output speed being proportional to the input signal. A remote set of Form C start/stop contacts (furnished by the Temperature Controls Contractor) shall control the inverter.

B. Start/Stop

1. Switch used to initiate command to start or stop the drive; operates in manual mode.
C. Inverter/Line
   1. Selector switch in the LINE mode shall disconnect the adjustable frequency system and bypass for direct across-the-line motor operation to the 3 phase, 60 Hertz supply.
   2. Selector switch in the INVERTER mode shall disconnect the 3 phase, 60 Hertz supply and the system shall operate in the mode as established by the inverter Manual/Auto switch.

D. Automatic Restart
   1. In the event of a loss of supply line power, or an overvoltage/undervoltage condition of more than 5%, or in the event of a shutdown signal from the temperature control or fire detection system, the system shall shut down. When line power is restored, the system shall automatically restart after a time delay, providing the start contact is a maintained contact in the closed position and all external interlocks are satisfied.
   2. For motors started frequently, the system shall provide start at almost zero RPM and gradually increase to required speed.

3.03 ADJUST AND CLEAN
   A. Inspect operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movement.
   B. Touch up scratched or marred surfaces to match original finish.
   C. The carrier frequency shall be adjusted to optimize motor and VFD operation while reducing motor noise.

3.04 FIELD QUALITY CONTROL
   A. Subsequent to wire/cable hook-up, energize controllers and demonstrate functioning of equipment in accordance with requirements; where necessary correct malfunctioning units.

END OF SECTION 26 29 23
PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 26 00 10 - Electrical General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Contractor shall furnish, install and place in operation the emergency light and power system work as indicated by drawings and schedules.

B. Refer to other Division-26 sections for wires/cables raceways, and electrical boxes and fittings work required in connection with emergency light and power systems.

1.03 QUALITY ASSURANCE

A. NEC compliance: Comply with NEC as applicable to wiring methods, materials, construction and installation of emergency light and power systems.

B. UL Compliance: Comply with applicable requirements of UL 924, "Emergency Lighting and Power Equipment". Provide ELP system components which are UL-listed and labeled.


D. IEEE Compliance: Comply with applicable requirements of IEEE standards pertaining to semiconductor rectifier components.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's data on emergency light and power systems and components.

B. Shop Drawings: Submit dimensioned drawings of emergency light and power systems and accessories including, but not necessarily limited to rectifiers, inverters, static transfer switches, maintenance switches, batteries, and instruments. Show accurately scaled layouts of emergency light and power system equipment and their spatial relationship to associated equipment; show connections to normal and standby electrical power feeders.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products of one of the following:

1. Evenlite
2. Crucial Power Products/Perfect Power Systems
3. Philips Chloride
4. Dual Lite
5. IOTA Engineering
6. Myers
2.02 EMERGENCY LIGHTING POWER SYSTEMS, 490 WATTS AND LESS

A. Basis of Design: Evenlite

B. General: The Emergency Lighting Power System shall be a solid-state single phase unit designed to provide regulated and conditioned sinusoidal power for emergency lighting applications. The Emergency Lighting Power System shall provide uninterrupted power during all modes of operation. There shall be no interruption of power to the lighting system when the unit transfers to and from battery operation. The Emergency Lighting Power System and battery subsystem shall be listed to UL 924 Standard for Emergency Lighting and Power Equipment by a nationally recognized organization.

C. Capacity: As indicated on the drawings. The Emergency Lighting Power System shall be able to operate at the specified capacity regardless of the type of lighting load including LED.

D. Input/Output Voltage: 120 or 277 volt as indicated on the drawings.

E. Circuit Breakers: Provide with 3, output circuit breaker. Output shall be normally on.

F. Batteries: Sealed, maintenance-free batteries shall be provided. The batteries shall have an expected life of ten (10) years. The batteries shall be fully wired and contained within a battery section. Battery run time (based on 100% full load) shall be no less than ninety (90) minutes.

G. Monitoring Panel: Front panel display indicating system status. The unit display shall indicate the following:
   1. Lighting Power System On. Power is present at the input and the system has been turned on.
   2. Output Available. Indicating system is providing power to the system output.
   3. Battery Mode. Indicating system is operating in battery mode.

H. Provide wall mounting bracket.

2.03 EMERGENCY LIGHTING POWER SYSTEMS, 500-2100 WATTS

A. Basis of Design: Crucial Power Products Econosine II

B. General: The Emergency Lighting Power System shall be a solid-state single phase unit designed to provide regulated and conditioned sinusoidal power for emergency lighting applications. The Emergency Lighting Power System shall provide uninterrupted power during all modes of operation. There shall be no interruption of power to the lighting system when the unit transfers to and from battery operation. The Emergency Lighting Power System and battery subsystem shall be listed to UL 924 Standard for Emergency Lighting and Power Equipment by a nationally recognized organization.

C. Capacity: As indicated on the drawings. The Emergency Lighting Power System shall be able to operate at the specified capacity regardless of the type of lighting load including LED.

D. Input/Output Voltage: 120 or 277 volt as indicated on the drawings.

E. Circuit Breakers: Provide with output circuit breakers.

F. Batteries: Sealed, maintenance-free batteries shall be provided. The batteries shall have an expected life of ten (10) years. The batteries shall be fully wired and contained within a battery section. Battery run time (based on 100% full load) shall be no less than ninety (90) minutes.
G. Monitoring Panel: Front panel display indicating system status. The unit display shall indicate the following:

1. **Indicating Lights.**
   a. Lighting Power System On. Power is present at the input and the system has been turned on.
   b. Output Available. Indicating system is providing power to the system output.
   c. Battery Mode. Indicating system is operating in battery mode.

2. **LCD display indicating system status, input/output voltage, battery voltage, battery capacity remaining, output load, temperature and event history.**

H. Provide floor mounting bracket.

I. Refer to the drawings for the quantity of normally on and normally off circuit breakers.

2.04 **EMERGENCY LIGHTING POWER SYSTEMS, 2.1kW to 17kW**

A. **Basis of Design:** Crucial Power Products Wave Rider I

B. **General:** The Emergency Lighting Power System shall be a solid-state single phase unit designed to provide regulated and conditioned sinusoidal power for emergency lighting applications. The Emergency Lighting Power System shall provide uninterrupted power during all modes of operation. There shall be no interruption of power to the lighting system when the unit transfers to and from battery operation. The Emergency Lighting Power System and battery subsystem shall be listed to UL 924 Standard for Emergency Lighting and Power Equipment by a nationally recognized organization.

C. **Capacity:** As indicated on the drawings. The Emergency Lighting Power System shall be able to operate at the specified capacity regardless of the type of lighting load including LED.

D. **Input/Output Voltage:** 120 or 277 volt as indicated on the drawings.

E. **Circuit Breakers:** Provide input, output and DC circuit breakers.

F. **Batteries:** Sealed, maintenance-free batteries shall be provided. The batteries shall have an expected life of ten (10) years. The batteries shall be fully wired and contained within a battery section. Battery run time (based on 100% full load) shall be no less than ninety (90) minutes

G. **Monitoring Panel:** Front panel display indicating system status. The unit display shall indicate the following:

1. **Indicating Lights.**
   a. Lighting Power System On. Power is present at the input and the system has been turned on.
   b. Output Available. Indicating system is providing power to the system output.
   c. Battery Mode. Indicating system is operating in battery mode.

2. **LCD display indicating system status, input/output voltage, battery voltage, battery capacity remaining, output load, temperature and event history.**

H. Provide NEMA 1 floor mounted enclosure.

I. **Surge Protection:** ANSI/IEEE C62.45 category A and B.

J. **Testing and Self-diagnostics:** Continuous self-diagnostics, battery exerciser and self-testing.
K. Refer to the drawings for the quantity of normally on and normally off circuit breakers.

PART 3 - EXECUTION

3.01 INSTALLATION OF EMERGENCY LIGHT AND POWER SYSTEMS

A. Install emergency light and power systems as indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that ELP system equipment complies with requirements. Comply with requirements of NEC, and applicable portions of NECA'S "Standard of Installation" pertaining to general electrical installation practices.

B. Coordinate with other electrical work, including cables/wires, raceways, electrical boxes and fittings, as appropriate to interface installation of emergency light and power systems work with other work.

C. Install floor mounted units on a concrete housekeeping pad. Pad to be 4 inches high, with chamfered edges. Extend base no more than 3 inches in all directions beyond the maximum dimensions of equipment unless otherwise indicated.

3.02 GROUNDING

A. Provide equipment grounding connections, sufficiently tight to assure permanent and effective ground, for emergency light and power system equipment as indicated.

3.03 LOAD WIRING

A. All branch circuits connected to the output circuit breakers are considered an emergency power supply system (EPSS) and shall be installed in a separate conduit system.

3.04 FIELD QUALITY CONTROL

A. Upon completion of installation of emergency lighting power system equipment, and after building circuitry has been energized with normal power source, test ELP system to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.

3.04 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Verify that central battery inverter is installed and connected according to the Contract Documents.

C. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 26 Sections.

D. Complete installation and startup checks according to manufacturer's written instructions.

3.05 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain central battery inverters.

END OF SECTION 26 33 23
PART 1 - GENERAL

1.01 SUMMARY

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 26 00 10 - Electrical General Provisions are applicable to work required of this section.

B. Section Includes: Surge Protective Devices (SPD) for Service Entrance and Branch Panel applications.

1.02 REFERENCES

A. ANSI/IEEE C.62.41 and C62.45
B. UL 1449 – 3rd Edition
C. UL 1283
D. NEC – NFPA 70
E. NEMA LS1
F. NFPA
G. OSHA
H. IEEE Std. 1100

1.03 SUBMITTALS

A. Shop Drawings: Provide Shop Drawings with wiring diagrams, installation information, testing and maintenance procedures, and operational information for the transient protection system. Shop Drawings shall be submitted to Design Professional for approval before starting actual fabrication.

B. Submittals for Approval: Provide the following test data submittals:

1. Manufacturer will provide UL-1449, Third Edition data card showing the Voltage Protection Rating (VPR) and “Engineering Considerations” for the specific catalog number submitted. “Typical” UL 1449, Third Edition data is not acceptable.

2. Per the requirements of NEC Article 285.6, the devices shall be marked with the short circuit current rating. This rating shall meet or exceed the available fault current. Test data shall be provided to demonstrate the short circuit current rating has been tested on a complete device.

3. Submit test report data clearly demonstrating the maximum surge current rating has been tested on a COMPLETE SPD unit including all necessary fusing/overcurrent protection, thermal disconnects, integral disconnects and monitoring systems.

4. Submit data demonstrating that the SPD unit is capable of surviving the specified minimum repetitive surge current rating. The rating is based on surviving a specified number of ANSI/IEEE C62.41, Category C3 (10kA) impulses without failure or degradation in performance characteristics of more than 10%.

5. Provide a COMPLETE third party data and test package with full documentation.
PART 2 - SERVICE ENTRANCE SPD

2.01 ENVIRONMENTAL

A. General Requirements:
   1. No audible noise shall be generated.
   2. No appreciable magnetic fields shall be generated. System shall be capable of use directly in computer rooms in any location without danger to disc units, disk packs, or tapes.
   3. Operating Conditions:
      a. 30 – 130 Degrees F
      b. 15 – 85 Percent Humidity Non-Condensing
   4. Enclosure: The unit shall have a heavy duty NEMA 12 dust-tight, drip-tight enclosure unless specified otherwise.

2.02 GENERAL REQUIREMENTS

A. SPD shall be rated for a 208Y/120 volt, 60 Hertz, 3-phase, 4-wire system and shall be connected in parallel with the main Distribution Power Panel.

B. Quality: The manufacturer shall be ISO 9001 certified, demonstrating world-class quality systems for the design and manufacture of the SPD units.

C. Unit shall be UL 1449, 3rd Edition Listed. A SPD that is a UL “Recognized” component will not be accepted.

D. Each surge suppression element (MOV) shall be individually fused so that a failure of one element and/or fuse shall not affect other surge suppression elements. SPD shall have a short-circuit rating of 200kAIC.

E. Unit shall include solid-state, long-life externally mounted LED visual status indicators that indicate the on-line status and operational integrity of each phase of the unit.

F. Unit shall have a Form C summary alarm output contact rated for at least 1 amp at 120VAC for remote annunciation of SPD status.

2.03 MANUFACTURERS AND SPECIFIC PRODUCT REQUIREMENTS

A. Acceptable Manufacturers: Subject to compliance with requirements of the Contract Documents, acceptable manufacturers are as follows:
   1. Emerson Network Power: 560 Series
   2. Current Technology: SL3 Series

B. Unit shall provide maximum UL 1449 3rd Edition Voltage Protection Rating for 208Y/120 Volt systems as follows:
   1. L-N = 700V
   2. L-G = 700V
   3. N-G = 700V
   4. L-L = 1000V
C. Unit shall provide maximum UL 1449 3rd Edition Voltage Protection Rating (VPR) for 480Y/277 Volt systems as follows:

1. L-N = 1000V
2. L-G = 1200V
3. N-G = 1000V
4. L-L = 1800V

D. The SPD will be modular in design. Separate and replaceable suppression modules will protect each mode (L-N, L-G, and N-G).

E. The service entrance SPD will be capable of surviving 15,000 ANSI/IEEE, Category C3 (10kA) impulses without failure or degradation of original performance characteristics of more than 10%

F. Unit shall have a maximum surge current rating of 125kA per mode (125,000 amperes L-N, 125,000 amperes L-G, and 125,000 amperes N-G), based on ANSI/IEEE C62.41 standard by 20 microsecond current waveform. Manufacturers shall provide a higher maximum surge current rated device if required to meet the requirements of paragraph D. above.

G. Unit shall be UL 1283 listed as an electromagnetic interference filter and provide 50 Ohm noise attenuation of at least 40 dB at 100 kHz, 30 dB at 1 MHz, 35 dB at 10 MHz, and 50 dB at 100 MHz.

H. Unit shall include a built-in, push-to-test feature that tests the integrity of all modules, MOVs and fuses in the system.

I. Unit shall be provided with an integral, non-fused disconnect switch which causes no interruption to the protected load for testing and maintenance. Disconnect system shall not require removal or replacement for warranty or other repairs.

J. Warranty: Manufacturer shall provide a product warranty for a period of not less than 10 years from date of installation. Warranty shall cover unlimited replacement of system protection modules during warranty period. The first 5 years of this warranty will include any field labor required to perform repair or replacement work.

2.04 MANUFACTURERS AND PRODUCT REQUIREMENTS

A. Acceptable Manufacturers: Subject to compliance with requirements of the Contract Documents, acceptable manufacturers are as follows:

1. Emerson Network Power: 510 Series
2. Current Technology: TG Series

B. Unit shall provide maximum UL 1449 3rd Edition Voltage Protection Rating (VPR) for 208Y/120 Volt systems as follows:

1. L-N = 800V
2. L-G = 900V
3. N-G = 700V
4. L-L = 1200V

C. Unit shall provide maximum UL 1449 3rd Edition Voltage Protection Rating (VPR) for 480Y/277 Volt systems as follows:

1. L-N = 1200V
2. L-G = 1200V
3. N-G = 1000V
4. L-L = 2000V

D. The service entrance SPD will be capable of surviving 10,000 ANSI/IEEE, Category C3 (10kA)
impulses without failure or degradation of original performance characteristics of more than 10%

E. Unit shall have a maximum surge current rating of 125kA per mode (125,000 amperes L-N, 
125,000 amperes L-G, and 125,000 amperes N-G), based on ANSI/IEEE C62.41 standard 8 by 
20 microsecond current waveform. Manufacturers shall provide a higher maximum surge current 
rated device if required to meet the requirements of paragraph D. above.

F. Unit shall be UL 1283 listed as an electromagnetic interference filter and provide 50 Ohm noise 
attenuation of at least 40 dB at 100 kHz, 30 dB at 1 MHz, 35 dB at 10 MHz, and 50 dB at 100 
MHz.

G. NOTES: The SPD can be connected to the service entrance equipment either through a 60A 
breaker provided by the equipment manufacturer or directly connected to the equipment bus bar. 
If a 60A breaker is not available or practical, then specify the integral disconnect and keep 
paragraph G below. If the SPD will be connected by a 60A breaker, then specify this on the 
drawings and ensure that the breaker is included on the equipment schedule.

H. Unit shall be provided with an integral, non-fused disconnect switch which causes no interruption 
to the protected load for testing and maintenance. Disconnect system shall not require removal 
or replacement for warranty or other repairs.

I. Warranty: Manufacturer shall provide a product warranty for a period of not less than 10 years 
from date of installation.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General Requirements:

1. Contractor shall install suppression system immediately next to or on top of service 
equipment where so approved by the Design Professional:

2. Conductors between suppressor and point of attachment to service equipment shall be 
sized in accordance with manufacturer’s Shop Drawings and conductor lengths shall be 
as short as possible, preferably not exceeding 24”.

B. Grounding: Suppressor ground shall be bonded to the equipment grounding conductor and 
service entrance ground.

END OF SECTION 26 43 13
SECTION 26 50 00 - LIGHTING

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 26 00 10 - Electrical General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Provide lighting fixtures, accessories, labor and supervision necessary to install complete lighting system as required by the drawings and this section.

B. Types of lighting fixtures in this section include the following:

   1. Solid State (LED)
   2. Exit Signs
   3. Emergency
   4. Lamps
   5. Exterior Luminaires

1.03 QUALITY ASSURANCE

A. NEC Compliance: Comply with NEC as applicable to installation and construction in building lighting fixtures.

B. NEMA Compliance: Comply with applicable requirements of NEMA standard publications pertaining to lighting equipment.

C. Listings: Provide lighting fixtures which have been listed and labeled. Listing or labeling shall be by UL, ETL Intertek or other nationally recognized agency.

D. CBM Labels: Provide fluorescent-lamp ballasts which comply with Certified Ballast Manufacturers Association standards and carry the CBM label.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's data on interior building lighting fixtures.

B. Shop Drawings: Submit fixture shop drawings in booklet form with separate sheet for each fixture, assembled in luminaire "type" alphabetical order, with proposed fixture and accessories clearly indicated on each sheet. Shop drawing booklet shall include lamp and ballast data sheets.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturers shall be as listed in the light fixture schedule on the drawings.
B. Basis of Design Product: The design for each luminaire is based on the product named and described in the light fixture schedule on the drawings. Provide either the named product or a comparable product by one of the equivalent manufacturers listed. Equivalent manufacturers shall match the basis of design product in both form and function. The Architect and Engineer have the final acceptance of equivalent products. Where equivalent products are not determined to match the basis of design, the basis of design product shall be provided at no additional cost to the Owner. Upon request, equivalent manufacturers shall submit lighting calculations and IES files to prove performance of product and samples for tabletop viewing.

2.02 SOLID STATE LIGHTING / LIGHT EMITTING DIODE (LED) LUMINAIRES (Greater than 20W)

A. General:

1. Luminaire manufacturer shall have a minimum of five (5) years’ experience in the manufacture and design of LED products and systems.

2. All LED sources used in the LED luminaire shall be of proven quality from established and reputable LED manufacturers. Acceptable LED lamp manufacturers unless otherwise noted are:

   a. Cree, Inc.
   b. Philips Lighting
   c. Nichia Corporation
   d. Norlux
   e. Opto Technology, Inc.
   f. Osram Optronic Semiconductors
   g. Samsung

B. LED Warranty

1. Luminaire manufacturer provide a five (5) year written warranty.

C. Replacement and Spares:

1. The following requirements apply to all LED fixtures except:

2. Manufacturer shall provide written guarantee of the following:

   a. Manufacturer shall be able to provide compatible replacement parts that are designed to fit into original luminaire for ten (10) years.

   b. Replacement LED array/module shall be within 3 MacAdam color ellipse, within 10% of lumen output, 7% of correlated color temperature (CCT) and equivalent distribution of original array/module.

   c. Replacement LED array/module shall utilize equal to or less than amount of wattage of original array/module.

2. LED driver and array/module shall be replaceable in field.

D. Products and Components – Performance:

1. All LED components shall be mercury-free and lead-free.


3. LEDs shall comply with IESNA LM-80 – Standards for Lumen Maintenance of LED Lighting Products.

4. LEDs shall have a minimum rated source life of 50,000 hours under normal operating conditions or as noted on the lighting fixture schedule. LED “rated source life” is defined as the time when a minimum of 70% of initial lumen output remains, as defined by IESNA LM-70.
5. Luminaire assembly shall include a method of dissipating heat so as to not degrade life of source, electronic equipment, or lenses. LED luminaire housing shall be designed to transfer heat from the LED board to the outside environment. Luminaire housing shall have no negative impact on life of components. Upon request, manufacturer shall provide junction temperature limitations and test reports of installed LED in fixture.

6. Method of dissipating heat shall be passive, active cooling systems are not allowed.

7. High power LED luminaires shall be thermally protected using one or more of the following thermal management techniques: metal core board, gap pad, and/or internal monitoring firmware.

8. LEDs shall be adequately protected from moisture or dust in interior applications.

9. For wet and damp use, LED-based luminaires itself shall be sealed, rated, and tested for appropriate environmental conditions, not accomplished by using an additional housing or enclosure. Such protection shall have no negative impact on rated life of source or components, or if so, such reductions shall be explicitly brought to the attention of the designer.

10. All hardwired connections to LED luminaires shall be reverse polarity protected and provide high voltage protection in the event connections are reversed or shorted during the installation process.

11. Manufacturer shall provide Luminaire Efficacy (lm/W), total luminous flux (lumens), luminous intensity (candelas) chromaticity coordinates, CCT and CRI. Optical performance, polar diagrams, and relevant luminance and illuminance photometric data. Provide data in IES file format in accordance with IES LM-79-2008, based on test results from an independent Nationally Recognized Testing Laboratory. Provide information upon special request.

E. LED drivers shall meet the following requirements:

1. Drivers shall have a minimum efficiency of 85%.

2. Minimum/Maximum Ambient Temperature: -20˚C/55˚C interior locations, -40˚C/55˚C exterior locations.

3. Input Voltage: 120 to 277 (±10%) V or as scheduled.

4. Power Supplies: Class I or II output.

5. Dimming Type: 0-10V control with current source driver, current sinking drivers are not allowed.

6. Surge Protection for exterior fixtures: The system must survive 250 repetitive strikes of "C Low" (C Low: 6kV/1.2 x 50 μs, 10kA/8 x 20 μs) waveforms at 1-minute intervals with less than 10% degradation in clamping voltage. "C Low" waveforms are as defined in IEEE/ASNI C62.41.2-2002, Scenario 1 Location Category C.

7. Power Factor (PF): ≥ 0.90.

8. Total Harmonic Distortion (THD): ≤ 20%.


10. Drivers shall be reduction of hazardous substances (ROHS)-compliant.

11. Mean Time Between Failure (MTBF): 100,000 hours based on 90% survival.

2.03 EXIT SIGNS

A. Housing to be per light fixture schedule (thermoplastic, edge lit or cast aluminum) for wall, end or ceiling mounting. Illumination to be by long life, low watt LED lamps. Battery, where specified, to be maintenance free, sealed nickel-cadmium type and shall operate sign for 90 minutes after loss of power.

2.04 EMERGENCY FIXTURES

A. Housing and lamping per light fixture schedule. Self contained complying with UL 924. Battery to be premium grade, lead-acid or nickel cadmium, maintenance free battery and shall operate sign for 90 minutes after loss of power.
2.05 EXTERIOR LUMINAIRES

A. General:

1. Poles shall be as shown on the drawings, and as specified. The pole and arm assembly shall be designed for wind loading of 100 mph with an additional 30% gust factor, supporting luminaire(s) and accessories such as shields, banner arms, and banners.

2. Poles shall have handhole having a minimum clear opening of 2.5 x 5 in. Handhole covers shall be secured by stainless steel captive screws.

3. Provide a steel-grounding stud opposite handhole openings, designed to prevent electrolysis when used with copper wire.

4. Provide a base cover that matches the pole in material and color to conceal the mounting hardware pole-base welds and anchor bolts. Plastic base covers are not allowed.

5. Hardware and Accessories: All necessary hardware and specified accessories shall be the product of the pole manufacturer.

6. Provide manufacturer's standard finish and color, as scheduled on the drawings. Provide custom finishes only where specifically indicated on the drawings.

B. Pole Types:

1. Aluminum: Provide aluminum poles manufactured of corrosion-resistant AA AAH35.1 aluminum alloys conforming to AASHTO LTS-4. Poles shall be seamless extruded or spun seamless type. Poles 12' or greater in height shall be provided with an internal, factory installed, vibration damper.

2. Steel: Provide steel poles having minimum 11-gauge steel with minimum yield/strength of 48,000 psi. Poles 12' or greater in height shall be provided with an internal, factory installed, vibration damper.

3. Prestressed Concrete: Provide prestressed concrete, raceway-type, lighting poles of the size and type indicated. Provide luminaire brackets as required for complete assemblies.

C. Foundations for Poles:

1. Foundations shall be cast-in-place concrete, having 3000 psi minimum 28-day compressive strength.

2. Place concrete in spirally-wrapped treated paper forms for round foundations, and construct forms for square foundations.

3. Rub-finish and round all above-grade concrete edges to approximately 0.25 in radius.

4. Anchor bolt assemblies and reinforcing of concrete foundations shall be as shown on the drawings. Anchor bolts shall be in a welded cage or properly positioned by the tie wire to stirrups.

5. Prior to concrete pour, install ground electrode.

PART 3 - EXECUTION

3.01 INSTALLATION OF INTERIOR LIGHTING FIXTURES

A. Install interior lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of the National Electric Code (NEC), NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.

B. Coordinate with other electrical work as appropriate to properly interface installation of interior lighting fixtures with other work.

C. Coordinate fixture location with reflected ceiling plan.
D. Recessed fixtures in removable ceilings shall be connected to the branch circuit with flexible conduit and branch circuit wire from an accessible junction box. Where fluorescent fixture housings are connected together, use 90 deg.C wire for branch circuit feed through fixture channels.

E. All fixtures shall be grounded. All lamp sockets shall be wired so that the outer shell is connected to the neutral grounded conductor.

F. Fixtures recessed in furred ceiling shall be installed so that they can be removed from below the ceiling.

G. For all dimmed light fixtures, “burn in” or “season” lamps prior to dimming as recommended by the lamp manufacturer.

H. Luminaires located in suspended ceilings shall be connected with a maximum 6 foot length of flexible metal conduit and building wire.

I. Housing, trim, and lens frame shall be true, straight and parallel to each adjacent fixtures and features.

J. Contractor shall include all materials and labor necessary for the final aiming and adjusting of adjustable light fixtures. Adjustment of light fixtures may be required to occur after sunset at a time designated by the Engineer.

K. Round fixtures or fixtures smaller than the ceiling grid shall have at least two (2) 3/4 inch (19 mm) metal channels spanning, and secured to, the ceiling tees for centering and aligning the fixture.

L. Troffer, recessed and semi-recessed fixtures shall be installed at a minimum per the manufacturer’s instructions and the requirements below. Fixtures shall not be supported directly on the ceiling material. Support fixtures with metal bar hangers or strut channels attached to the ceiling tees. Coordinate with Ceiling Contractor to ensure ceiling tees can support the weight of the light fixtures.

M. Suspended Linear or Pendant mounted fixtures shall be independently supported from the building structure by wires, straps or rods.

N. Fixture whips shall be in accordance with section 26 05 33 Raceway and Boxes for Electrical Systems.

3.02 INSTALLATION OF EXTERIOR LIGHTING FIXTURES

A. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole. Install poles plumb and level.

B. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer.

C. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.

D. Embedded Poles with Tamped Earth Backfill: Set poles to depth below finished grade indicated on drawings, but not less than one-sixth of pole height. Dig holes large enough to permit use of tampers in the full depth of hole. Backfill in 6 inch layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.
E. Coordinate locations and elevations of base mounted site fixtures with site plans, do not scale electrical drawings for placement of light poles.

END OF SECTION 26 50 00
SECTION 26 82 39 - UNIT HEATERS

PART 1 - GENERAL

1.01 RELATED WORK

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 26 00 10 - Electrical General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

A. Provide material, equipment, labor and supervision necessary to install unit heaters as required by the drawings and this section.

1.03 UNIT HEATERS

A. Unit heaters shall include the following:

   1. Electric Unit Heaters and Cabinet Unit Heaters

1.04 SUBMITTALS

A. Submit shop drawings and/or catalog cuts showing technical data necessary to evaluate the equipment, to include color charts, dimensions, wiring diagrams, performance data and other descriptive data necessary to describe fully the terminal units.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Electric Unit Heaters and Cabinet Unit Heaters

   1. Trane
   2. Berko - (Division of Marly)
   3. Q-mark - (Division of Marly)
   4. Brasch
   5. Indeeco

2.02 ELECTRIC UNIT HEATERS

A. Units shall have capacities and ratings and shall be of arrangement as scheduled on the drawings.

B. Units shall be furnished complete with coils, enclosures, fans and motors as required to make complete functioning units.

C. Units to be installed in finished areas to be furnished with bonderized, phosphatized, flow-coated baked-on primer with spray applied baked-on enamels in color as selected by Design Professional from the manufacturer’s standard offering.

D. Motors for unit heaters and cabinet unit heaters shall be totally enclosed, Class 'B' insulation, with built-in overload protection, and shall be prewired to terminal strip in factory mounted junction box.
E. Filters for cabinet unit heaters shall have 1" thick woven glass replaceable media, and permanent aluminum frames.

F. Units shall have single point, line voltage connection for incoming power for 208, 240 or 480 volt services.

G. Provide the following accessories:
   1. Thermostat with external adjustable knob.
   2. Three position fan selector switch.
   3. Pilot light to indicate when heating elements are energized.
   4. Disconnect switch.

2.03 ELECTRIC UNIT HEATERS - INDUSTRIAL

A. Electric unit heaters shall be UL Listed for corrosive areas and NEMA 4X hose down requirements. Heater to be forced fan type of the KW rating, voltage and phase specified in the schedule.

B. The heating elements shall be type 304 stainless steel of finned tubular construction with stainless steel fittings.

C. The motor shall be UL recognized, totally enclosed with permanently lubricated ball bearings, designed to resist moisture and corrosion, fitted with an epoxy coated fan blade and factory wired to NEMA 4X enclosure.

D. Heating elements and motor to be enclosed in round, heavy 16 gauge stainless steel shroud, with stainless steel louvered outlet grille and plated rear grille.

E. Single point, line voltage connection for incoming power for 208, 240, and 480V heaters.

F. NEMA 4X enclosure to house element terminals and following standard built-in controls: Automatic reset over temperature cutout, 24V control transformer, fan delay relay, required contactors, and terminal block for field wiring. For heaters above 12 KW, a separate motor contactor will be supplied.

G. Provide the following accessories:
   1. Thermostat with external adjustable knob.
   2. Three position selector switch.
   3. Pilot light to indicate when heating elements are energized.
   4. Disconnect switch.

H. Accessory thermostat shall be furnished with each heater for remote wall mounting. thermostat shall be UL Listed with NEMA 4X enclosure suitable for wet and corrosive areas.

I. Chlorine Areas: Chlorine resistive construction shall include the following:
   1. Monel 400 Fin Element.
   2. Epoxy coating of all exposed stainless steel.
   3. Epoxy coating of aluminum fan and cabinet.

PART 3 - EXECUTION

3.01 Install units and make electrical connection as indicated on drawings.
3.02 Controls: Install devices furnished by manufacturer but not specified to be factory-mounted.

A. Verify that wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

END OF SECTION 23 82 39
SECTION 27 00 10 - TELECOMMUNICATIONS GENERAL PROVISIONS

PART 1 - GENERAL

1.01 GENERAL

A. Refer to Bidding Information, conditions of the Contract and Division I, General Requirements, which all apply to work under this section.

B. Project is a multi-year phased project. Refer to plans for phasing notes as they relate to delivery of equipment. Contractor must account for appropriate price increases and or secure storage of materials and equipment to comply with phasing requirements.

1.02 DESCRIPTION OF WORK

A. This section applies to all work under the telecommunications contract. This shall include, but not necessarily be limited to, the following:

1. Pre-Register Project with structured cabling plant manufacturer if applicable.
2. Furnish and install a complete voice and data-wiring infrastructure.
3. Furnish, install, and terminate all UTP cable and fiber as applicable and per drawings.
4. Furnish and install all wall plates, jacks, patch panels, and patch cords as required and as indicated.
5. Furnish and install any cabinets, racks and ladder rack as required and as indicated.
6. Furnish any other material required to form a complete system.
7. Perform permanent link testing (100% of links) and certification of all components.
8. Furnish test results of all cabling to the owner on disk and paper format, listed by each closet, then by workstation ID.
9. Provide Owner As-builts in the form of one electronic copy and two hard copies of a labeled map of the building(s) showing the structured cabling plant.
10. Adhere and comply with all requirements of the Contractor Agreement for the structured cabling plant manufacturer to be used.
11. Provide Owner training and testing documentation.

B. The work shall include all materials, equipment and labor required for complete and properly functioning telecommunications systems.

C. All elements of the construction shall be performed by workmen skilled in the particular craft involved, and regularly employed in that particular craft.

D. All work shall be performed in a neat, workmanlike manner in keeping with the highest standards of the craft.

1.03 CODES AND STANDARDS

A. All work shall be done in accordance with the applicable portion of the following codes and standards:

1. National Electrical Code 2014
2. Local Electrical Code, refer to Cedar Rapids local ordinances
3. National Fire Protection Association
4. National Electrical Manufacturers Association
5. Standards of Institute of Electrical and Electronic Engineers
6. Applicable Building Codes
7. Occupational Safety and Health Act
8. Iowa Administrative Codes
10. ANSI TIA-526-14-C Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
11. ANSI TIA-568-D.0 Generic Telecommunications Cabling For Customer Premises
13. ANSI TIA-568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standards
14. ANSI TIA-568-C.3 Optical Fiber Cabling Components Standard
15. ANSI TIA-568-C.4 Broadband Coaxial Cabling and Components Standard
16. ANSI TIA-569-D Telecommunications Pathways and Spaces
17. ANSI TIA-570-C Residential Telecommunications Infrastructure Standard
18. ANSI TIA-598-D Optical Fiber Cable Color Coding
19. ANSI TIA-606-B Administration Standard for Commercial Telecommunications Infrastructure
20. ANSI TIA-607-B Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
21. ANSI TIA-758-B Customer-owned Outside Plant Telecommunications Infrastructure Standard
22. National Fire Protection Agency (NFPA - 70), National Electrical Code (NEC)

B. All Contractors shall familiarize themselves with all codes and standards applicable to their work. No extra compensation will be allowed for corrections or changes in the work required due to failure to comply with the applicable codes and standards. Where two or more codes or standards are in conflict, that requiring the highest order of workmanship shall take precedence, but such questions shall be referred to Design Professional for final decision.

1.04 REQUIREMENTS & FEES OF REGULATORY AGENCIES

A. Contractor shall comply with the rules and regulations of the local serving utility companies and shall check with each utility company providing service to this project and determine or verify their requirements regarding incoming services.

B. Secure and pay for all permits, licenses, fees and inspections.

1.05 DRAWINGS

A. Drawings for the work are in part diagrammatic, and are intended to convey the scope of the work and to indicate in general the location of equipment.

B. Contractor shall layout his own work and shall be responsible for determining the exact quantities and locations for equipment.

C. Contractor shall take own field measurements for verifying locations and dimensions; scaling of the drawings will not be sufficient for laying out the work.

D. Because of the scale of the drawings, certain basic items for a complete installation are not shown, but where such items are required by code (or referenced standards) where they are required for proper installation and operation of the work, such items shall be furnished and installed.

1.06 ACTIVE SERVICES

A. Contractor shall be responsible for verifying exact locations of all existing services prior to beginning work in that area.
B. When active services are encountered which require relocation, Contractor shall make request to authorities with jurisdiction for determination of procedures.

C. Where existing services are to be abandoned, they shall be terminated in conformance with requirements of the authorities having jurisdiction.

1.07 SITE INSPECTION

A. Contractor shall inspect the site prior to submitting bid for work to become familiar with the conditions of the site which will affect the work and shall verify points of connection with utilities and/or existing system wiring.

B. Extra payment will not be allowed for changes in the work required because of Contractor's failure to make this inspection.

1.08 COORDINATION AND COOPERATION

A. It shall be Contractor's responsibility to schedule and coordinate work with the schedule of General Contractor so as to progress the work expeditiously, and to avoid unnecessary delays.

B. Contractor shall fully examine the drawings and specifications for other trades and shall coordinate the installation of his work with the work of the other contractors. Contractor shall consult and cooperate with the other contractors for determining space requirements and for determining that adequate clearance is allowed with respect to his equipment, other equipment and the building. The Design Professional reserves the right to determine space priority of the contractors in the event of interference between piping, conduit, ducts and equipment of the various contractors.

C. Drawings and specifications are intended to be complimentary. Any work shown in either of them, whether in the other or not, shall be executed according to the true intent and meaning thereof, the same as if set forth in all. Conflicts between the drawings and the specifications, or between the requirements set forth for the various contractors, shall be called to the attention of the Design Professional. If clarification is not asked for prior to the taking of bids, it will be assumed that none is required and that Contractor is in agreement with the drawings and specifications as issued. If clarification is required after the contract is awarded, such clarification will be made by Design Professional and his/her decision will be final.

D. Special care shall be taken for protection for all equipment. All equipment and material shall be completely protected from weather elements, painting, plaster, etc., until the project is substantially completed. Damage from rust, paint, scratches, etc., shall be repaired as required to restore equipment to original condition.

E. Protection of all equipment during the painting of the building shall be the responsibility of the Painting Contractor, but this shall not relieve Contractor of the responsibility for checking to assure that adequate protection is being provided.

F. Where the final installation or connection of equipment in the building requires Contractor to work in areas previously finished by Owner, the Contractor shall be responsible that such areas are protected and are not marred, soiled or otherwise damaged during the course of such work. Contractor shall be responsible for patching and refinishing of such areas which may be damaged in this respect.

G. Where two or more specified items/systems in the specifications and/or the drawings are in conflict, that requiring the highest order of workmanship and the most financially expensive products shall take precedence. Such questions shall be referred to the Design Professional for final decision.
1.09 MATERIALS AND EQUIPMENT

A. All materials and equipment shall be the standard product of a reputable manufacturer regularly engaged in the manufacture of the specified item unless authorized in writing by Design Professional. Where more than one unit is required of the same items, they shall be furnished by the same manufacturer except where specified otherwise.

B. All material and equipment shall be installed in strict accordance with the manufacturer's recommendations.

C. The equipment specifications cannot deal individually with any minute items such as parts, controls, devices, etc., which may be required to produce the equipment performance and function as specified, or as required to meet the equipment guarantees. Such items when required shall be furnished as part of the equipment, whether or not specifically called for.

1.10 COORDINATION DRAWINGS

A. Coordination Drawings:

1. Prepare Coordination Drawings for all areas of the building (new and existing) to facilitate installation coordination amongst all disciplines and trades. Each drawing shall be broken out by phase and submitted separately after equipment submittals have been approved.

   a. Content: Project-specific information, drawn accurately to scale. Do not base Coordination Drawings on reproductions of the Contract Documents or standard printed data. Include the following information, as applicable:

      1) Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems. As part of the spatial relationship requirement, the Contractor shall take field dimensions in existing areas to confirm available space for installations prior to completing the coordination drawings.

      2) Indicate required installation sequences.

      3) Indicate dimensions shown on the Contract Drawings and make specific note of dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect for resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

   b. Drawing scale: Coordination drawings shall be drawn at minimum ¼” =1'-0" scale.

   c. Coordination meeting(s): A coordination meeting will be scheduled after coordination drawings are received from all sub-contractors for review and discussion. Subsequent meetings will be scheduled for follow up and resolution to conflicts. These meetings shall be led by the General Contractor.

   d. Scheduling: Installation of system components will not be allowed until after coordination meeting(s) and all coordination issues are resolved.

1.10 SUBMITTALS

A. Contractor shall furnish, to the Design Professional, complete sets of submittals. Contractor shall review and sign submittals before submitting. Contractor shall provide submittals via electronic process (.PDF format) unless otherwise instructed.

B. Submittals shall be bound into sets per specification section (not division). The content of the submittal shall cover related items for a complete system as much as practical and items shall be identified with symbols or "plan marks" used on drawings whenever possible. Incomplete, piecemeal or unbound submittals will be rejected.
C. Each submittal shall include a cover sheet providing the Approved Contractors company name, address, phone number and contact person (person to contact if there are questions about the submittal). The cover sheet shall also have adequate white space for the design professional review stamp as well as up-stream contractor stamps. The company providing the submittal shall be the same as that which meets the APPROVED CONTRACTOR requirements paragraph found later in this specification section (submittals without this identifying contractor information on the cover page will be rejected to ensure the Approved Contractor process is being followed).

D. Design Professional will review submittals solely to assist contractors in correctly interpreting the plans and specifications.

E. Contract requirements cannot be changed by submittals. Contract documents remain in force even if equipment is submitted which differs from contract drawings and specifications and that submittal is stamped as reviewed (or any other stamp verbiage).

F. Submittals required by the various sections of the Project Manual include, but are not necessarily limited to those identified in the submittal schedule below.

G. After award of contract, the contractor shall provide a completed submittal schedule including dates that the submittals will be to the Design Professional for review.

H. It shall be the Contractors responsibility to confirm that the equipment physically fits in the space allotted. This will require the Contractor to field verify existing spatial elements and lay out their work prior to ordering equipment, ideally this will occur prior to submitting shop drawings. Where conflicts exist, notify the Design Professional prior to equipment order.

I. Submit required information on all items in the project for the following systems (see table). Submittals shall be sorted and separately identified per specification section listed below.

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<tr>
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<tr>
<td>27 60 00</td>
<td>School Clock System</td>
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<td>X</td>
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### Notes:

1. Division 27 Contractor shall submit copies of the Contractor Certifications under section 27 00 10 (BICSI or IBEW/NECA Certifications) showing compliance with the specification. See Approved Contractors paragraph for details.
2. Division 27 Contractor shall submit Manufacturer Certification under section 27 00 10. See Approved Contractors paragraph in this section for details, and further requirements listed in Cabling and Equipment specification section.
3. Division 27 Contractor shall submit As-Builts as specified in Cabling and Equipment section.
4. Division 27 Contractor shall submit product information on UTP Tester and Fiber Tester. See testers specified in Testing and Documentation section.
5. Division 27 Contractor shall submit Test Report as specified in Testing and Documentation section.
6. Grounding and Bonding or Cabling and Equipment section submittals will not be opened or reviewed by the Design Professional until the Division 27 00 10 Contractor Certifications (see Note 1) and Division 27 Manufacturer Certifications (see Note 2) have been received and found to be acceptable by the Design Professional.
7. Division 27 Contractor shall submit the "Do Not Paint The UTP" written notification (addressed to the General Contractor) for review by the Design Professional. This written notification is specified in the Telecommunications Cabling and Equipment section. The submittal process may be used as the vehicle to inform the General Contractor of the "Do Not Paint The UTP" requirement (and the mandatory corrections required if this were to happen, outlined in the Telecommunications Cabling and Equipment section) if the General Contractor acknowledges receipt of the written notification.

### 1.11 OPERATION AND MAINTENANCE MANUALS

A. Operation and maintenance manuals shall be submitted to the Design Professional in duplicate upon completion of the job. Manuals shall be bound in a three ring hard-backed binder. Front cover and spine of each binder shall have the following lettering done:

```
OPERATION
AND
MAINTENANCE
MANUAL
FOR
TELECOMMUNICATIONS SYSTEMS

(PROJECT NAME)
(LOCATION)
(DATE)

SUBMITTED BY
(NAME, ADDRESS AND PHONE NUMBER OF CONTRACTOR)
```

B. Provide a master index at the beginning of manual showing items included. Each section shall contain the following information for equipment furnished under this contract:

1. Equipment and system warranties and guarantees.
2. Installation instructions.
3. Operating instructions.
5. Spare parts identification and ordering list.
6. Local service organization, address, contact and phone number.
7. Submittals with reviewed stamp of Design Professional and Contractor shall be included, if applicable, along with the items listed above.
1.12 TESTS AND DEMONSTRATIONS

A. All systems shall be tested by Contractor and placed in proper working order prior to demonstrating systems to Owner.

1.13 TRAINING AND DEMONSTRATIONS

A. Prior to acceptance of the telecommunications installation, the Contractor shall provide to Owner, or his designated representatives, all comprehensive training on essential features and functions of all systems installed, and shall instruct Owner in the proper operation and maintenance of such systems.

1. Provide adequate notice to Owner as to when instruction will be conducted so appropriate personnel can be present.
2. Prepare the instruction format for a minimum of four Owner Representatives.

B. Equipment training:

1. Manufacturer’s representatives shall provide instruction on each major piece of equipment. Contractor shall provide instruction on all other equipment.
2. Training sessions shall use the printed installation, operation and maintenance instruction materials included in the O&M manuals and emphasize preventative maintenance and safe operating procedures.
3. Training shall be performed by qualified factory trained technicians.
4. Contractor shall attend all sessions performed by the manufacturer’s representative and shall add to each session any special information relating to the details of installation of the equipment as it might impact the operation and maintenance.
5. Equipment training shall occur as soon as possible after start up of the equipment and shall include hands-on operation. Training shall be provided for equipment listed in the table below.

C. System training:

1. Training sessions shall include hands-on demonstrations of system wide start-up, operation in all possible modes, shut-down and emergency procedures.
D. The following are minimum requirements for Owner instruction:

<table>
<thead>
<tr>
<th>Sections</th>
<th>Description</th>
<th>Hrs. on Site</th>
<th>Hrs. off Site</th>
<th>Presented By</th>
<th>Others Present</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>27 11 00</td>
<td>Cabling and Equipment</td>
<td>2</td>
<td>Contractor</td>
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<tr>
<td>27 40 00</td>
<td>Audiovisual System</td>
<td>4</td>
<td>Contractor</td>
<td>1, 2, 3</td>
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<tr>
<td>27 50 00</td>
<td>Intercom System</td>
<td>4</td>
<td>Contractor</td>
<td>1, 2, 5</td>
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<td>27 50 00</td>
<td>Video Intercom System</td>
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<td>Contractor</td>
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<td>27 60 00</td>
<td>School Clock System</td>
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<td>Contractor</td>
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Remarks:
1. Perform complete system test at time of instruction.
2. Owner could have up to 20 in attendance at each session.
3. Total hours to be divided into several sessions over the first 6 months of warranty period for each phase.
4. Any unused hours shall be used at Owner’s discretion during the first year of occupancy.
5. Total hours to be divided into two sessions over the first 6 months of warranty period.

E. Each Contractor shall submit a certificate (in the project closeout submittals), signed by Owner stating the date, time and persons instructed and that the instruction has been completed to Owner’s satisfaction. An example of a certificate form is as follows:
CERTIFICATE OF SYSTEM DEMONSTRATION

This document is to certify that the contractor has demonstrated the hereafter listed systems to Owner’s representatives in accordance with the Contract documents and that the instruction has been completed to the Owner’s satisfaction.

A. Project:

B. System(s):

C. Contractor’s representatives giving instruction and demonstration:

Contractor: _____________________________

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<tr>
<th>NAMES</th>
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<th>HOURS</th>
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D. Owner’s representatives receiving instruction:

Owner: ________________________________

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<tr>
<th>NAMES</th>
<th>DATE</th>
<th>HOURS</th>
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Acknowledgement of demonstration:

E. Contractor’s Representative:

_____________________________
signature

date

Owner’s Representative:

_____________________________
signature

date

TELECOMMUNICATIONS GENERAL PROVISIONS 27 00 10 - 9
1.14 PERMITS, FEES, ETC.
A. Secure all required permits and pay for all inspections required in connection with the telecommunication systems work. Contractor shall post all bonds and obtain all licenses required by the State, City, County, and Federal Agencies.

1.15 SUBSTITUTIONS
A. To obtain approval to use unspecified equipment, Bidding Contractors (not equipment supplier, manufacturers, etc.) shall submit written requests to Design Professional at least 10 days prior to bid due date. Requests shall clearly describe the equipment for which approval is being requested. Include all data necessary to demonstrate that equipment's capacities, features and performance are equivalent to include a cost comparison between specified equipment and equipment for which approval is being requested. If the equipment is acceptable, Design Professional will approve it in an addendum. The Design Professional will, under no circumstances, be required to prove that an item proposed for substitution is or is not of equal quality to the specified item.

B. Where substitutions are approved, Contractor assumes all responsibility for physical dimensions and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades because of the substitution.

1.16 APPROVED CONTRACTORS
A. MANUFACTURER CERTIFICATION: Contractor shall be a manufacturer certified installer for the structured cabling plant. A copy of the current annual manufacturer certification shall be provided with 27 0010 submittals. Contractor is responsible for workmanship and installation practices in accordance with the manufacturer requirements and shall be authorized to provide an extended Manufacturer's Product Warranty with his installation. The specific warranty program that is acceptable for each solution is listed with the connectivity solution in specification section 27 1100 TELECOMMUNICATIONS SYSTEMS CABLING AND EQUIPMENT. Contractors shall provide proof upon request that they have maintained the Manufacturers Certification in good standing for at least six months prior to the overall project bid. Temporary or short term certifications (less than the standard 12-month annual certification described above) or case-by-case certifications are not acceptable.

B. CONTRACTOR CERTIFICATION: Contractor shall meet one of the following two paragraphs and provide appropriate documentation in the 27 0010 submittals:

1. Contractor shall have BICSI Registered Installers and Technicians on staff and assign them to this project. The project shall be staffed at all times by Installers and Technicians who, in the role of lead craft-persons, will be able to provide leadership and technical resources for the remaining craft-persons on the project. A minimum of 30 percent of personnel shall be BICSI registered telecommunications installers. Of that number 15 percent shall be registered at the Technician Level, at least 40 percent shall be registered at the Installer Level 2, and the balance shall be registered at the Installer Level 1. Contractor shall provide BICSI certifications showing employee name, level, and expiration date. BICSI certificate for the highest level attained shall be submitted.

2. Contractor shall have employees on staff and assigned to the project that are currently indentured in or have successfully completed the IBEW/NECA three-year Telecommunications Installer/Technician registered apprenticeship program. Contractor shall maintain a ratio of 1 Technician to 1 indentured Apprentice. Contractor shall provide documentation verifying the indentured status of Apprentices, and the Department of Labor Certificates of Completion for the Installer/Technicians.
C. Contractor pulling the telecommunications cabling (if different from the prime Telecommunications Contractor) shall meet all the same BICSI or IBEW/NECA requirements, and requirements of this specification, as the prime Telecommunications Contractor.

D. Contractor shall be located within 125 miles of the construction site to establish a potential two hour response time for ongoing customer needs after construction completion.

1.17 ACCEPTABLE MANUFACTURERS

A. In most cases, equipment specifications are based on a specific manufacturer's type, style, dimensional data, catalog number, etc. Listed with the base specification, either in the manual or on the drawing schedules, are acceptable manufacturers approved to bid products of equal quality. These manufacturers are encouraged to submit to Design Professional at least 8 days prior to the bid due date drawings and catalog numbers of products to be bid as equals.

B. Manufacturers, who do not submit prior to bidding, run the risk of having the product rejected at time of shop drawing submittal. Extra costs associated with replacing the rejected product shall be the responsibility of Contractor and/or the manufacturer.

C. If Contractor chooses to use a manufacturer listed as an equal, it shall be his responsibility to assure that the manufacturer has complied with the requirements in 'A' above. Contractor shall assume all responsibility for physical dimensions, operating characteristics, and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of using the alternate manufacturer.

D. Where a model or catalog number is provided, it may not be inclusive of all product requirements. Refer to additional requirements provided on the plans or in the specifications as required. Similarly, there may be additional requirements included in the model or catalog number that are not specifically stated. These requirements shall also be met.

1.18 QUALITY ASSURANCE

A. Contractor shall be a company specializing in telecommunication cable and/or accessories with a minimum of five years documented experience in installation of cable and/or accessories similar to those specified below.

1.19 WARRANTY AND SERVICES

A. The entire telecommunications system including all sub-systems shall be guaranteed against defect in materials and installation for a minimum of two years from substantial completion or beneficial occupancy whichever occurs earlier. Any malfunctions which occur within the guarantee period shall be promptly corrected without cost to Owner. This guarantee shall not limit or void any manufacturer's express or implied warranties.

B. Manufacturer Product Warranty shall be provided which warrants functionality of all components used in the system for 20 years from the date of registration. The Manufacturers Product Warranty shall warrant the installed horizontal and/or backbone copper, and both the horizontal and the backbone optical fiber portions of the cabling system.

C. Continuing Maintenance: The contractor shall furnish an hourly rate with the proposal submittal, which shall be valid for a period of one year from the date of acceptance. This rate will be used when cabling support is required to affect moves, adds, and changes to the system (MACs). MACs performed by an approved Contractor shall be added to the warranty.
D. Final Acceptance & System Certification: Completion of the installation, in-progress and final inspections, receipt of the test and as-built documentation, and successful performance of the cabling system for a two week period will constitute acceptance of the system. Upon successful completion of the installation and subsequent inspection, the end user shall be provided with a numbered certificate registering the installation.

1.20 CHANGES IN THE WORK

A. A Contract Change Order is a written order to Contractor signed by Owner and Contractor, issued after the execution of the Contract, authorizing a change in the Work or an adjustment in the Contract Sum or the Contract Time. The Contract Sum and the Contract Time may be changed only by Contract Change Order.

B. Owner, without invalidating the Contract, may order changes in the Work within the general scope of the Contract consisting of additions, deletions or other revisions, with the Contract Sum and the Contract Time being adjusted accordingly. All such changes in the Work shall be authorized by Contract Change Order and shall be performed under the applicable conditions of the Contract Documents.

C. The cost or credit to Owner resulting from a change in the Work shall be determined by mutual acceptance of a lump sum properly itemized and supported by sufficient substantial data to permit evaluation. Change Orders shall be submitted with each item listed individually with a material cost and labor unit extension. Overhead and profit, as mutually agreed upon between Owner and Contractor shall be added to material and labor cost figures.

D. It shall be the responsibility of Contractor before proceeding with any change to satisfy himself that the change has been properly authorized on behalf of Owner.

1.21 GROUNDING AND BONDING OF SYSTEMS

A. All low voltage systems shall be subject to the Telecommunications Grounding and Bonding specification section 27 1000. For those systems which may require a specialized sub-contractor, the sub-contractor providing and installing systems shall also be responsible for grounding and bonding per this specification.

1.22 COMPLETION

B. Systems, at time of completion, shall be complete, efficiently operating, non-hazardous and ready for normal use by Owner.

C. When all the work is complete Contractor shall thoroughly clean all material and equipment installed as a part of this contract and leave all equipment and material in new condition.

D. Contractor shall clean up and remove from the site all debris, excess material and equipment left during the progress of this contract at job completion.

END OF SECTION 27 00 10
SECTION 27 05 53 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish and install all materials, equipment and labels required as shown on the Drawings, Schedules and as specified.

B. It is the intent of the Specifications, Drawings and Schedules that all labels be legible and provided in locations which are readily visible.

C. Only those items affected by the installation of the project shall be labeled unless otherwise indicated.

D. Project is a multi-year phased project. Refer to plans for phasing notes as they relate to delivery of equipment. Contractor must account for appropriate price increases and or secure storage of materials and equipment to comply with phasing requirements.

1.2 STANDARDS

A. Unless otherwise noted, all labels at distribution frames shall follow the color coding scheme identified in ANSI/TIA/EIA 606 “Administration Standard for the Telecommunications Infrastructure of Commercial Buildings”.

1.3 DRAWINGS AND SPECIFICATIONS

A. The Contractor shall keep a detailed up-to-date record of the label information and placement of all labels installed as specified herein.

1.4 SUBMITTALS

A. Submit product data for the following:

1. Labeling machine.
2. Labels

1.5 CLEANING

A. The Contractor shall clean all surfaces prior to the attachment of labels. Follow the manufacturer’s recommendations for cleaning.

B. The Contractor shall follow the manufacturer’s recommendations for affixing labels.

PART 2 - PRODUCTS

2.1 TERMINATION HARDWARE AND CABLE LABELS

A. Acceptable Manufacturers:

1. Brady
2. Brother
3. DYMO
PART 3 - EXECUTION

3.1 SPACES

A. Item: Main Telecommunications Closet (MTC)
   The MTC for both copper and fiber terminations, has been pre-assigned and should be labeled by the contractor in a visible location as entering the space with minimum 2” high black on orange machine printed labels.

   Example: MTC-A

3.2 CABLING

3.2.1 Copper Cabling

A. Item: Building Copper cable (BC)
   The BC is interior multi-pair copper riser cable extending from the MTC to TC.

   Label Location: On the cable at both ends, near the hardware on which the cable is terminated.

   Label Information: The Cable identifier is the letters BC followed by the cable number (2 numeric characters) and the Cable Pair Count (4 numeric characters) and the identifying telecommunication room letter. Both the beginning and end count. The Cable identifier is unique to the building. The Building copper cable identifier shall be assigned by the Contractor and recorded on the Communications Systems Identification Record document under the heading Building Copper.

   Method: Black on white wire wrap machine printed label.

   Format: All capital letters. Font should be as large as possible to fill the label space with the information. The font should be Helvetica or equal and bold. One line centered formatted text. Use dash as delimiter.

   Example: BC01-0001-0100-A

B. Item: Horizontal Copper Cable
   The Horizontal Copper Cable extends from the MTC or TC to any field side location requiring voice or data service within the defined serving boundaries of the said MTC or TC.

   Label Location: On the cable at both ends, near the hardware on which the cable is terminated.

   Label Information: The Cable identifier is the letters (TC) followed by the serving TC identification letter and the 3 numeric characters field assigned by the Telecom Contractor during installation. The Cable identifier is unique to the TC. The Horizontal Copper Cable shall be recorded on the Communications Systems Identification Record document under the heading Jack ID. (see end of section)
Method: Black on white wire wrap machine printed label.

Format: All capital letters. Font should be as large as possible to fill the label space with the information. The font should be Helvetica or equal and bold. One line centered formatted text. Use dash as delimiter.

Example: TC-A-001

C. Item: Patch Cables (data)
The patch cables are used to connect data services to the user service locations and are plugged into the electronics or patch panels at the other end of the cable.

Label Location: On the end of the patch cable at the plug of both ends.

Label Information: Patch cable identifier (4 numeric characters).

The patch cable identifier is sequential. The sequence is unique to the TC. The patch cable identifier shall begin with 0001 and end with the number corresponding to the quantity of jumpers installed in the closet. The patch cable identifier shall be assigned by the Contractor and recorded on the Communications Systems Identification Record document under the heading “Data Patch Cable Identifier” provided for each Telecommunication room. (see end of section)

Method: Black on white machine printed wire wrap labels.

Format: The font should be as large as possible to fill the label space with the information. The font should be Helvetica or equal and bold. One line format.

Example: 0001

D. Item: Patch Cables (voice)
The patch cables are used to connect voice services to the user service locations and are plugged into the electronics or patch panels at the other end of the cable.

Label Location: On the end of the patch cable at the plug of both ends.

Label Information: Patch cable identifier (Alpha characters).

The patch cable identifier is sequential. The sequence is unique to TC. The patch cable identifier shall begin with the letter A and end with the letter corresponding to the quantity of patch cables installed in the closet. When Z is reached, the sequence will start over again with double alpha characters. (AA) The patch cable identifier shall be assigned by the Contractor and recorded on the Communications Systems Identification Record document under the heading “Voice Patch Cable Identifier” provided for each Telecommunication room. (see end of section)

Method: Black on white machine printed wire wrap labels.
Format: The font shall be all Caps and as large as possible to fill the label space with the information. The font should be Helvetica or equal and bold. One line format.

Example: A to Z after Z follow with AA to ZZ

### 3.2.2 Fiber Cabling

**A. Item:** Building Fiber cable

The (BF) is an interior fiber riser cable extending from the MTC to the Telecommunications Closet (TC).

**Label Location:** On the jacket or sheath of the cable at both ends (before the fanout or breakout point). Place the label near the cable entrance into the termination hardware and exterior to the termination hardware.

**Label Information:** The cable identifier is the letters BF followed by the cable number (2 numeric characters) and the Cable Strand Count (4 numeric characters) and the identifying telecommunication room letter. Both the beginning and end count. The cable identifier is unique to the building. The building fiber identifier shall be assigned by the Contractor and recorded on the Communications Systems Identification Record document under the heading Building Fiber. (see end of section)

**Method:** Black on white wire wrap machine printed label and large enough to wrap around itself to protect the print.

**Example:** BF01-0001-0012-A

**B. Item:** House Fiber cable (HF)

The (HF) is an interior fiber cable extending from the MTC or TC to any work area within the building that is not a communications room.

**Label Location:** On the jacket or sheath of the cable at both ends (before the fanout or breakout point). Place the label near the cable entrance into the termination hardware and exterior to the termination hardware.

**Label Information:** The cable identifier is the letters HF followed by the cable number (2 numeric characters) and the Cable Strand Count (4 numeric characters) and the identifying telecommunication room letter. The HF cable identifier is unique to the building. The HF identifier shall be assigned by the Contractor and recorded on the Communications Systems Identification Record document under the heading House Fiber. (see end of section)
Method: Black on white wire wrap machine printed label and large enough to wrap around itself to protect the print.

Format: All capital letters. Font should be as large as possible to fill the label space with the information. The font should be Helvetica or equal and bold. One line format. Center text. Use dash as delimiter.

Example: HF01-0001-0012-A

3.3 TERMINATION HARDWARE

3.3.1 Copper Termination Hardware

A. Item: Outlet faceplate
   The outlet faceplate is typically a 2-port or 4-port faceplate.

   Label Location: On the top of the faceplate in the outlet location window and behind the clear plastic window.

   Label Information: Outlet location number (8 alpha and numeric characters). The information shall match the outlet location number assigned by the contractor during installation. Outlet numbers are unique to the serving telecommunication room. Each outlet/jack number assigned by the Contractor and the room the jack is installed to shall be recorded on the Communications Systems Identification Record document under the heading Jack Identification and Jack Room Location.

   Method: Manufacturer’s white paper inserts. Print the information on an adhesive label and affix the label to the paper insert. Labels shall not be affixed to the clear plastic window. The orientation of the text on the label for the 2-port faceplates shall match the 4-port faceplates. Use only machine printed labels sized for purpose.

   Format: Font should be sized to fill the area of the strip. The font should be Helvetica or equal and bold. One line format.

   Example: TC-X-XXX

C. Item: Horizontal Copper Cable Patch Panels
   The patch panel for horizontal copper cable is located in the MTC or TC and installed in the equipment rack in pre-assigned rack units. The patch panel provides a connection point for voice and data service in the MTC or TC to any field side location within the defined serving boundaries of the said MTC or TC.

   Label Location: In the manufactures designated port label location.
Label Information: Outlet location number (8 alpha and numeric characters). The information shall match the outlet location number assigned by the contractor during installation. Outlet numbers are unique to the serving telecommunication room. Each outlet/jack number assigned by the Contractor and the room the jack is installed to shall be recorded on the Communications Systems Identification Record document under the heading Jack Identification and Jack Room Location.

Method: Black on white machine printed manufacture patch panel labels.

Format: Font shall be sized to be readable, fitting all characters required within the manufacture provided area. The font should be Helvetica or equal and bold. One line format.

Example: TC-A-001

C. Item: Telco Patch Panels
The BC cables are terminated on a 25 or 50 port/pair voice Cat.3 RJ45 19in 1RU patch panel. If a 25 or 50 port/pair patch panel is not provided by the selected cable manufacturer from Sec. 27 1100-2.01B. A patch panel from any of the other approved manufacturers in Sec. 27 1100-2.01B can be submitted for approval by the Engineer.

Label Location A: One single label on the face of the patch panel identifying the BC and serving TC.

Example: BC01-A

Label Location B: At the provided patch panel port label location.

Label Information: Copper Cable count (as applicable) per port.

Method: Black on white machine printed adhesive Labels.

Format: Font should be sized to be readable and to fit all information required without overlap of text. The font should be Helvetica or equal. One line format.

Example: Port 1: 0001 Port 2: 0002
"Port 1:" is for example purpose only and is not to be included on label.

3.3.2 Fiber Termination Hardware

A. Item: Fiber Housing enclosures including the following (FH):

CCH (Closet Connector Housing)
WCH (Wall-mountable Closet Housing)

Label Location: On the outside of the enclosure and on the flat facing (i.e., front) surface in the top left corner.
Label Information: The Fiber enclosure identifier is the letters FH followed by the enclosure number (4 numeric characters). The Fiber enclosure identifier is unique to the Building. The fiber enclosure identifier shall be assigned by the Contractor and recorded on the Communications Systems Identification Record document under the heading Fiber housing.

Method: Machine printed 2.25" W x 1.25" H component Label.

Format: Font should be sized to fill the label space with the information. The font should be Helvetica or equal and bold. One line format.

Example: FH-0001

3.3.3 Fiber Terminations

A. Item: Building fiber terminations

The connector layout within each enclosure may vary. In general, the columns of fiber connectors are grouped in units of six connectors. Columns count from left to right. Terminations positions within a column count from top to bottom. The connector adapters are Duplex LC. All connectors will be LC.

Label Location: On the inside front panel of the enclosure in the location identified by the manufacturer for the label. Use the manufacturer’s label placard that is enclosed with the hardware.

Label Information: The label information includes a Panel identifier, the Building Fiber cable identifier, and the fiber strand assignment.

The Panel identifier (1 alpha character). The Panel identifier shall begin with the letter A and end alphabetically corresponding to the quantity of panels in the enclosure. All occupied panels within the enclosure shall be labeled. The Panel identifier is unique to the enclosure. The Panel identifier is assigned by the Contractor.

The Building Fiber cable identifier is defined under the Item: Building Fiber cable (BF).

The BF strand count is unique to the BF. The sequence begins with 0001.

Method: Machine printed component Labels.

Sized to fit the provided labeling card of the fiber housing manufacturer.

Format: Font should be sized to fill the label space with the information without overlap of the next column. The font should be Helvetica or equal and bold. One line format.
3.4 EQUIPMENT AND EQUIPMENT RACKS

A. Item: Equipment Racks
The equipment racks are typically 19" free-standing or wall-mounted racks or cabinets.

Label Location: Top front and back cross bars of each equipment rack.

Label Information: The equipment rack identifier is the letters (ER) followed by the rack number (2 numeric characters). Start numbering from the front of the equipment rack, left to right. The equipment rack label information is shown on the drawing details. The equipment rack identifier is unique to the room.

Method: Machine printed 2.25" W x 1.25" H minimum component labels.

Format: All capital letters. The font should be sized to fill the label space with the information. The font should be Helvetica or equal and bold. One line format.

Example: DR01

3.5 GROUNDING AND BONDING

A. Item: Telecommunications Main Grounding Busbar (TMGB)
Label Location: On the left side of the busbar on the busbar wall standoff.

Label Information: The letters TMGB. The TMGB is unique to the building. The identifier information is identified on the grounding schematic detail of the drawings.

Method: Black on white machine printed 2.25" W x 1.25" H minimum component Label.

Format: All capital letters. Font should be as large as possible to fill the label space with the information. The font should be Helvetica or equal and bold. One line format.

Example: TMGB

B. Item: Telecommunications Grounding Busbar (TGB)
Label Location: On the left side of the busbar on the busbar wall standoff.
Label Information: The letters TGB followed by the sequence number (2 numeric characters). The sequence shall be unique to the building. The identifier information is identified on the grounding schematic detail on the drawings.

Method: Black on white machine printed 2.25" W x 1.25" H minimum component Label.

Format: All capital letters. Font should be as large as possible to fill the label holder space with the information. The font should be Helvetica or equal and bold. One line format.

Example: TGB-01

C. Item: Telecommunications Bonding Backbone (TBB)
The Telecommunications Bonding Backbone (TBB) bonds the TMGB to the TGB. There may be multiple TBBs. The quantity of TBBs depends on the methods used to interconnect the TGBs.

Label Location: On the conductor at each end and at each break in the insulation (for connection to another conductor or a busbar). The label shall be placed near the end of the insulation.

Label Information: The letters BB followed by the sequence number (1 numeric character). The sequence number shall be unique to the building. The identifier information is identified on the grounding schematic details on the drawings.

Method: Black on white machine printed 2" W x .75" H wire wrap label.

Format: All capital letters. Font should be as large as possible to fill the label space with the information. The font should be Helvetica or equal and bold. One line format.

Example: BB-1

D. Item: Telecommunication Bonding Conductor (TBC) bonds the Intersystem Building Busbar to the TMGB. Typically, there is only one TBC.

Label Location: On the conductor at each end. The label shall be placed near the end of the conductor at the connection to the Intersystem Building Busbar and the TMGB.

Label Information: The letters TBC followed by the sequence number (1 numeric character). The sequence number shall be unique to the building. The identifier information is identified on the grounding schematic detail on the drawings.

Method: Black on white machine printed 2" W x .75" H wire wrap label.
Format: All capital letters. Font should be as large as possible to fill the label space with the information. The font should be Helvetica or equal and bold. One line format.

Example: TBC-1

E. Item: Equipment Rack bonding conductor (RBC)
The equipment rack bonding conductor (RBC) bonds the TMGB and TGB to other metallic items, including electronic equipment.

Label Location: On the conductor at each end and at each break in the insulation (for connection to another conductor or a busbar). The label shall be placed near the end busbar or the break in the insulation whichever applies.

Label Information: The letters RBC followed by the sequence number (3 numerical characters). The sequence number shall be unique to the telecommunications closet. The contractor shall assign the numbers as necessary to accomplish the installation.

Method: Black on white machine printed wire wrap Label.
.50" W x .375" H.

Format: All capital letters. Font should be as large as possible to fill the label space with the information. The font should be Helvetica or equal and bold. One line format.

Example: RBC-001
Project: _________________________________________
Building: ________________________________________
Contractor Company: ________________________________
Technician: ________________________________________
Date: _____________________________________________

Telecommunication Room: M/TC- ________ Rm #: ________

<table>
<thead>
<tr>
<th>Fiber Housing</th>
<th>Building Fiber</th>
<th>Building Copper</th>
<th>Installed Jack Range</th>
<th>House Fiber</th>
</tr>
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<tbody>
<tr>
<td>FH_______</td>
<td>BF____-____</td>
<td>BC____-____</td>
<td>TC-<strong><strong>-</strong></strong></td>
<td>HF____-____</td>
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*Only note the Patch cable ID on the same row of the Jack ID that the patch cable was connected to.*

<table>
<thead>
<tr>
<th>Jack ID</th>
<th>Jack Rm. Loc.</th>
<th>Data Patch Cable ID</th>
<th>Voice Patch Cable ID</th>
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IDEENTIFICATION FOR COMMUNICATIONS SYSTEMS 27 05 53 - 11
<table>
<thead>
<tr>
<th>Jack ID</th>
<th>Jack Rm. Loc.</th>
<th>Data Patch Cable ID</th>
<th>Voice Patch Cable ID</th>
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END OF SECTION 27 05 53
SECTION 27 10 00 - TELECOMMUNICATIONS GROUNDING AND BONDING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 27 00 10 – Telecommunications General Provisions are applicable to work required of this section. Project is a multi-year phased project.

B. Refer to plans for phasing notes as they relate to delivery of equipment. Contractor must account for appropriate price increases and or secure storage of materials and equipment to comply with phasing requirements.

C. Project is a multi-year phased project. Refer to plans for phasing notes as they relate to delivery of equipment. Contractor must account for appropriate price increases and or secure storage of materials and equipment to comply with phasing requirements.

1.02 DESCRIPTION OF WORK

A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this grounding and bonding system in compliance with the applicable standards, specifications and drawings. Contractor will provide and install all of the required material to form a complete and operational system whether specifically addressed in the technical specifications or not.

B. All division 27 low voltage systems shall adhere to these grounding and bonding requirements.

1.03 SUBMITTALS

A. Submittal data for equipment, cabling, and hardware shall consist of catalog cuts showing technical data necessary to evaluate the materials with specific item designated by arrow or by being highlighted.

1.04 WORK BY OTHERS

A. The Intersystem Grounding Busbar located outside the main electrical service equipment will be installed as part of the main electrical gear and connected back to the various building grounding sources (ground rods, water pipe, building steel, etc.).

1.05 FIRESTOPPING

A. Contractor shall be responsible for fire stopping all conduit sleeves (internally only) and cable tray where required to maintain integrity of fire and/or smoke walls. The Contractor shall review architectural drawings to determine which walls have a fire and/or smoke rating. Any rating other than “non-rated” shall constitute a wall that requires fire stopping in all penetrations/openings.

PART 2 - PRODUCTS

2.01 GROUNDING EQUIPMENT

A. Telecommunications Main Grounding Busbar (TMGB): Panduit part number GB4B0624TPI-1.


C. Telecommunications Grounding and Bonding Conductor Label Kit: Panduit part number LTYK.
D. Data Rack Grounding Busbar, 19": Panduit part number RGRB19U.
E. Server Cabinet Grounding Busbar, Cagenut Mounting, 19": Panduit part number RGRB19CN.
F. Electrostatic Discharge Port Kit: Panduit part number RGESD2-1.

2.02 GROUNDING CABLEING

A. Cable used for Intersystem Grounding Busbar to Telecommunications Main Grounding Busbar (TMGB) shall be non-jacketed AWG #3/0 bare copper stranded grounding cable.
B. Cable used for Telecommunications Main Grounding Busbar (TMGB) to Telecommunications Grounding Busbar (TGB) shall be non-jacketed AWG #3/0 bare copper stranded grounding cable.
C. Cable used for Telecommunications Main Grounding Busbar (TMGB) or Telecommunications Grounding Busbar (TGB) to data racks/server cabinets inside the telecom room shall be AWG #6 copper stranded cable, green jacketed or bare copper.
D. Cable used for Telecommunications Main Grounding Busbar (TMGB) or Telecommunications Grounding Busbar (TGB) to any wall mounted low voltage system in the telecom room that requires grounding shall be AWG #6 copper stranded cable, green or bare copper.
E. Cable used for Telecommunications Main Grounding Busbar (TMGB) or Telecommunications Grounding Busbar (TGB) to the telecom room ladder rack system shall be AWG #6 copper stranded cable, green or bare copper.
F. Cable used for Cable Tray and/or Wire Basket grounding outside the telecom room shall be #6 AWG stranded bare copper cable.

2.03 GROUNDING HARDWARE

A. Two Hole Lug, Code Conductor, Long Barrel with Window, AWG #3/0 3/8” with 1” spacing. Panduit part number LCC3/0-38DW-X.
B. Two Hole Lug, Code Conductor, Long Barrel with Window, AWG #6 with 5/8” spacing. Panduit part number LCC6-14AW-L.
C. Paint Piercing Grounding Washer Kit with Antioxidant: Panduit parts.
D. Bonding Screws, #12-24: Panduit part number RGTBSG-C.

PART 3 - EXECUTION

3.01 STAR TOPOLOGY

A. The telecom grounding and bonding system shall be provided and installed in a star topology. Each building shall receive one Telecommunications Main Grounding Busbar (TMGB) in the designated telecom room or utility demarcation area (see below for location), and one Telecommunications Grounding Busbar (TGB) in each additional telecom room or identified specialty location (see below for locations). All TGBs shall receive a dedicated grounding connection back to the TMGB. The TMGB shall receive a dedicated grounding connection back to the building Intersystem Grounding Busbar (see Work By Others). The building Intersystem Grounding Busbar is usually just outside the main electrical service gear (interior to the building, visible on the wall.)
3.02 TELECOMMUNICATIONS MAIN GROUNDING BUSBAR (TMGB):

A. The TMGB shall be mounted on a wall toward the rear of the room, preferably out of the way of other equipment and walk ways.

B. The TMGB shall be mounted at an elevation approximately 6"-12" below the ladder rack in the room to allow easy access for grounding cables from the ladder rack, and to keep it up and out of the way for better technician safety.

3.03 TELECOMMUNICATIONS GROUNDING BUSBAR (TGB):

A. The TGB shall be mounted on a wall toward the rear of the room, preferably out of the way of other equipment and walk ways.

B. The TGB shall be mounted at an elevation approximately 6"-12" below the ladder rack in the room to allow easy access for grounding cables from the ladder rack, and to keep it up and out of the way for better technician safety.

3.04 TELECOMMUNICATIONS ROOM LADDER RACK

A. All telecom room ladder rack shall be bonded together and to the telecommunications grounding busbar in that room.

B. Bonding shall be accomplished per the following:

1. Use the #6 AWG green cable listed in the cable paragraph.
2. Use the #6 AWG two hole lugs listed in the hardware paragraph.
3. Use the bonding stud and bonding nuts listed in the hardware paragraph to secure the lug to the ladder rack.
4. Drill holes in ladder rack to accommodate the two hole lugs and bonding studs with bonding nuts.
5. Install bonding conductors in a neat and orderly fashion so as not to droop or hang away from the material it is bonding.
6. Use the #6 AWG two hole lugs to bond to the busbar.

3.05 TELECOMMUNICATIONS ROOM RACKS AND CABINETS

A. All telecom room racks and cabinets shall be individually bonded to the copper busbar in that room (the TMGB or TGB) using a dedicated cable installation.

B. Grounding the rack or cabinet to the copper busbar shall be accomplished per the following:

1. Use the #6 AWG green cable listed in the cable paragraph.
2. Use the #6 AWG two hole lugs listed in the hardware paragraph to connect to the telecom room grounding busbar.
3. Use the #6 AWG two hole lugs listed in the hardware paragraph to connect to the rack or cabinet grounding busbar.
4. Use the paint piercing washers listed in the hardware paragraph.
5. Install bonding conductors in a neat and orderly fashion so as not to droop or hang away from the material it is bonding.
6. Use the #6 AWG two hole lugs to bond to the busbar.
3.06 TELECOMMUNICATIONS CABLE TRAY AND/OR WIRE BASKET

A. All installations of cable tray and/or wire basket runs shall be bonded to the nearest copper busbar in a telecom room (the TGB or TMGB) using a AWG #6 stranded bare copper grounding conductor. The break point shall be at the same boundary as the UTP boundary between telecom rooms. Do not bond the cable tray or wire basket together across these boundaries as this could cause a grounding loop.

B. Bonding cable tray and/or wire basket shall be accomplished per the following:

1. The bare copper bonding conductor shall be one continuous run from the telecom room grounding busbar to the end of the cable tray and/or wire basket longest run. Remember to not bond across the boundaries (see above).

2. Additional branches of cable tray and/or wire basket that branch off the initial “longest run” shall have their own installation of continuous bare copper bonding conductor from the main run to the end. This run shall be mechanically and permanently bonded to the “longest run” using permanent crimp on Panduit lugs and the proper Panduit hydraulic tool for the job. The end result of this is like a tree with a main trunk and branches off that main trunk (the branches connect at the main trunk and do not need to individually run to the telecom room).

3. Each individual piece or stick of cable tray and/or wire basket shall be mechanically bonded to the bare copper grounding conductor.
   a) For cable tray, use a mechanical bonding lug with paint piercing washer and bolt with nylock nut through body of cable tray. The bare copper bonding cable shall slide into the “C” opening of the lug and be tightened using the lug stud.
   b) For wire basket, use a mechanical screw type compression lug.

END OF SECTION 27 10 00
SECTION 27 11 00 - TELECOMMUNICATIONS CABLING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 27 00 10 – Telecommunications General Provisions are applicable to work required of this section.

B. Refer to plans for phasing notes as they relate to delivery of equipment. Contractor must account for appropriate price increases and or secure storage of materials and equipment to comply with phasing requirements.

1.02 DESCRIPTION OF WORK

A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this structured cabling system in compliance with the specifications and drawings. Contractor will provide and install all of the required material to form a complete system whether specifically addressed in the technical specifications or not.

1.03 SUBMITTALS

A. Manufacturer and Contractor Certifications are required submittals in the division 27 General Provisions specifications section. The Manufacturer Certification is based on the material information listed below in the Acceptable Manufacturers paragraph.

B. Submittal data for cabling and components shall consist of catalog cuts showing technical data necessary to evaluate the materials.

1.04 WORK BY OTHERS

A. In general, the following is provided or is of note:

1. Architect will specify each dedicated telecom room fully lined on all walls from floor to 8' AFF (+96") with 0.75" fire retardant 3/4" AC plywood (A side visible after installation), painted with three coats of fire retardant bright white paint. Each sheet of plywood shall have one fire rating stamp masked off such that after painting this stamp is visible to the Authority Having Jurisdiction (AHJ). The Division 27 Contractor shall review the architectural drawings and be prepared to mount ladder rack and other equipment to masonry, gypsum, or other wall types if the plywood was omitted from the architectural design.

2. Electrical Contractor will provide field device back boxes and conduit paths for use by the Telecom or other division 27 Contractor.

3. The project painter may not be aware that ANY paint overspray (or direct application) of paint of any type (latex, oil based and ALL other paint types) to the UTP (unshielded twisted pair, generally called data cabling) voids the manufacturer's warranty and violates this specification. Paint may not be chemically or physically removed in any way once applied to the data cabling. Any cabling with paint overspray shall be fully replaced (no splicing therefore the entire run).

1.05 FIRESTOPPING

A. Contractor shall be responsible for fire stopping all conduit sleeves (internally only) and cable tray where required to maintain integrity of fire and/or smoke walls. The Contractor shall review architectural drawings to determine which walls have a fire and/or smoke rating. Any rating other than "non-rated" shall constitute a wall that requires fire stopping in all penetrations/openings.
PART 2 - PRODUCTS

2.01 COPPER UTP CABLE AND CONNECTIVITY PRODUCTS

A. Cabling and connectivity products (devices, cover plates, patch panels, insulation displacement connectors, etc.) must be part of a matched solution, provided by manufacturers that have been tested together and provide a fully certified end to end system.

B. Acceptable Manufacturers:

1. Belden Cat6a UTP connectivity (angled, modular patch panels) w/ Belden 10GXS Series Cat6a cable with 25 year Belden IBDN Component Warranty and Application Assurance Program provided by a Belden Certified System Vendor (CSV).

2. CommScope Systimax Cat6a UTP connectivity (angled, modular patch panels) w/ CommScope Systimax X10D Cat6a cable, with Systimax 20 year product and performance warranty.

3. Ortronics TracJack Cat6a UTP connectivity (angled, modular patch panels) w/ Superior Essex 10 Gain Cat6a cable, with the 25 year "nCompass" system warranty provided by an Ortronics CIP (Certified Installer Plus).

4. Panduit Mini-Com Cat6a UTP connectivity (angled, modular patch panels) w/ General GS10000 Cat6a cable with PanGenPlus 25 year system warranty provided by a Panduit Certified Installer.

C. Cable Jacket Rating:

1. Plenum

Note: If the above selection is not edited down to only one cable jacket type, the Contractor shall provide plenum rated cabling.

D. Additional Cabling and Connectivity Requirements:

1. Furnish and install cable between telecommunications room and field device locations as noted on the drawings.

2. Each field jack shall have a dedicated cable.

3. Provide cable terminations at telecommunications room.

4. Provide terminations at all field locations with an 8 pin, 8 conductor (RJ45 type) modular jack and flush wall plate per drawings.

5. Terminate using T568B wiring schematic unless noted otherwise.

6. Provide thermoplastic wall faceplates from the same connectivity manufacturer per location requirements for all field devices. Faceplate shall match electrical receptacle faceplates. Verify color/material before submittal time with Design Professional and include faceplate color/material choice in submittals.

7. All jacks shall be the same color as the thermoplastic faceplate. Provide at least 100 extra snap-on voice icons and at least 100 extra snap-on data icons to Owner. Contractor shall ask the Owner what two colors they want for voice and data icons respectively.

8. Configure faceplates as required for individual field locations per drawings.

9. Blanks shall be installed in all empty jack locations.

10. Provide terminations onto insulation displacement connectors for high pair count copper cables.

11. All patch panels shall be 24 port in 1RU (One EIA rack unit (1RU) = 1.75”). No (24 port in 2RU) patch panels allowed.

12. If multiple floors are being fed from one telecom room, the Contractor shall provide patch panels for each floor (do not continue from one floor to another on the same patch panel). Each floors patch panels shall be separated in the rack such that each floor may be expanded by 20% by putting the new patch panels in the original line up).
2.02 TELECOM ROOM EQUIPMENT

A. Please see table below for hardware selection:

<table>
<thead>
<tr>
<th>HARDWARE</th>
<th>PART #</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data Rack, Two Post.</strong> Mount to floor using minimum 3/8” bolt/lag/hardware.</td>
<td>CPI 55053-703</td>
</tr>
<tr>
<td><strong>Vertical Cable Management</strong></td>
<td></td>
</tr>
<tr>
<td>CPI Evolution g3 Combination, black (front solid door and side fingers, rear open with fold down arms):</td>
<td>CPI Evolution DS g3 10&quot;, 35573-703</td>
</tr>
<tr>
<td><strong>Horizontal Cable Management, 19” Rack Mounted.</strong></td>
<td>CPI Evolution 2RU, 35441-701</td>
</tr>
<tr>
<td>CPI Evolution, black. Provide &quot;n+1” for patch panels plus three (3) extra for Owner use per telecom room.</td>
<td></td>
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<tr>
<td><strong>Horizontal Cable Management, Ladder Rack.</strong> Use minimum #12 AWG x 1” screw for mounting. Toggle bolts, minimum 1/4” x 20, are also acceptable for hollow wall application if desired. Drywall screws shall not be used. Bond grounded ladder rack system to telecom room grounding bus bar with #6AWG green jacketed copper cable and two hole compression lugs.</td>
<td>12” is part # CPI 11275-712</td>
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</table>

B. The table above is design basis information. Once the Contractor has selected a product line to bid from 2.01, COPPER UTP CABLE AND CONNECTIVITY PRODUCTS, paragraph B, and if the connectivity manufacturer listed in that selection also manufacturers their own hardware equal to the CPI products listed, then the Contractor may use those products in place of the CPI products listed. If what is allowed in this paragraph is pursued, the Contractor assumes full liability for submitting and installing products which fully meet the criteria established by the CPI product, and also understands that if the engineer does not agree that the product meets the CPI design basis, the product line will revert back to mandatory installation of the CPI products listed, with any possible cost differences being fully the Contractors responsibility (including replacing installed hardware if this determination is made post-installation). Lastly, to be eligible to pursue this, the connectivity manufacturer shall offer an equivalent for each CPI part listed, and they all shall be used (no mixing manufacturers).

C. Cooper B-Line products are also an acceptable alternative to the CPI items in the table above. The Contractor assumes full liability for submitting and installing products which fully meet the criteria established by the CPI product, and also understands that if the engineer does not agree that the product meets the CPI design basis, the product line will revert back to mandatory installation of the CPI products listed, with any possible cost differences being fully the Contractors responsibility (including replacing installed hardware if this determination is made post-installation).

D. Please see the table below for power equipment selection:

<table>
<thead>
<tr>
<th>POWER EQUIPMENT</th>
<th>PART #</th>
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<tbody>
<tr>
<td>Power Distribution Unit, 19” rack mounted. Provides eight 15A receptacles on front, eight 15A receptacles on back, and has a 12’ cord with NEMA 5-15P plug which requires a NEMA 5-15R receptacle.</td>
<td>Tripp Lite PDUMH15AT</td>
</tr>
</tbody>
</table>
2.03 WIRE BASKET HORIZONTAL CABLE MANAGEMENT

A. Wire basket shall be provided and installed (generally outside of telecom rooms only) as shown on the plans.

B. Acceptable Manufacturers are:

1. Chatsworth Products (CPI), OnTrac Wire Mesh Cable Tray
2. Wire Basket Tray (WBT) Shaped Wire Basket Tray
3. Cooper B-Line, Flextray Cable Management
4. Legrand Cablofil, Wire Mesh Cable Tray
5. MonoSystems, Mono-Mesh Wire Basket Cable Tray

C. Additional Wire Basket Requirements:

1. All wire basket and hardware shall be galvanized (no other coatings) applied after product fabrication. This is to ensure a product that is made of an electrically conductive material for grounding purposes.
2. Whenever possible the Contractor shall continue the basket around corners and changes in elevation by applying the factory instructions for cutting and bending the material rather than stopping the material, forcing the cable to jump from one installation to the other.
3. The Contractor shall only cut the material with manufacturer approved cutters which leave a square edge, rather than bolt cutters which leave a sharp edge that can damage cables and severely injure installers or the Owner in the future.
4. Wire basket is shown in part diagrammatically on the plans. Conduit sleeves are shown passing through walls often with a stub symbol on each end (so the Electrical Contractor knows what to install) looking like they are 3’ or 4’ long, but in the field that sleeve will often not be any longer than the wall is thick (which is acceptable as long as it has bushings). The Contractor shall install the wire basket to the intended target shown on the plans (the destination of the cable that is, possibly the area below a floor box, wall sleeves, or other longer conduit pathway, etc.). The maximum air gap between wire basket and the cable destination horizontally shall be one foot (12”). The maximum air gap between wire basket and the cable destination vertically shall be two feet (24”).

2.04 LIGHTNING PROTECTION

A. Lightning protection shall be provided for all cabling that does not remain fully inside the building envelope.

B. Acceptable Manufacturers are:

1. Circa Telecom USA
2. Porta Systems

C. Additional Lightning Protection Requirements:

1. All cabling 25 pair or larger shall use an enclosed Building Entrance Terminal. This terminal shall be sized to accommodate all incoming cable pairs (full of 5 pin modules). Module selection shall be determined by the application chart found in manufacturer literature.
2. For applications smaller than 25 pair, the proper manufacturer recommended solution is acceptable (enclosed or not).
2.05 SINGLEMODE FIBER AND CONNECTIVITY PRODUCTS

A. Cabling and connectivity products (devices, coverplates, splice/termination panels, connectors, etc.) must be part of a matched solution, provided by manufacturers that have been tested together and provide a fully certified and guaranteed end to end system.

B. Acceptable Manufacturers:

1. The acceptable fiber solution shall be Corning Cable Systems hardware with Corning Brand Optical Fiber Cable (not someone else using Corning’s glass).

C. Additional Fiber and Connectivity Requirements:

1. The minimum grade of acceptable single mode fiber shall be OS2.
2. Provide and install buffer tube fan out kits for all OSP fiber.
3. Provide and install LC connectors for all singlemode fiber.
4. Installation method shall be mechanical connection (Uni-Cam).

2.06 FIRE ALARM PANEL CONNECTIONS

A. Two fire alarm panel information drops shall be furnished and installed by Contractor for each fire alarm head end panel. These drops shall be provided when required, whether they are pictorially shown on the plans or not.

B. Acceptable Manufacturers:

1. UTP cabling shall be the same as the Contractor will be installing per paragraph 2.01.B of this specification.
2. RJ31X connector shall be Elk Products, Inc.
3. RJ31X Connector may also be Engineer approved equal.

C. Additional RJ31X Requirements:

1. One RJ31X connector shall be used for each central office line; do not use the additional terminals inside the unit for a second line.
2. Contractor shall make necessary connections at demarcation location to insert RJ31X units into the lines between the demarcation (central office lines) and the lines to the premise wiring / phone system.

PART 3 - EXECUTION

3.01 UTP NO-PAINT WRITTEN NOTIFICATION REQUIREMENT

A. Many painters do not know that paint overspray of any quantity on voice/data UTP cabling (called UTP from here on) voids the manufacturer's extended warranty required by the specification. The Telecom Contractor shall notify the General Contractor in writing that the UTP cannot be painted (not even the slightest bit of overspray) and inform him or her that mechanical or chemical removal of paint is not allowed but rather full replacement of any cable that has received any amount of paint or paint overspray shall be fully replaced (no splicing allowed). This notification shall occur at least 30 days prior to any UTP being installed in the facility or brought on-site for storage.
3.02 INSTALLATION AND LABELING

A. Install telecommunication systems cables and auxiliary materials as indicated in accordance with manufacturer's written instructions, and recognized industry practices.
   a. See Section 27 05 53 for detailed labeling direction.

   1. In general, all interior cables are installed in conduit.
   2. D rings are allowed in telecommunications room as needed.
   3. Contractor shall use hook and loop type fasteners on all UTP telecommunications cable. Tie wraps may be temporarily used loosely for dressing UTP cables during installation if they are removed before final inspection. Any tie wrap found in place around UTP cable tight enough that a 0.5" wooden dowel cannot be inserted into the bundle at the tie wrap location shall therefore obligate the Contractor to replace those potentially damaged UTP cables at the Design Professionals discretion, whether they pass electronic testing or not.
   4. Tie wraps may be used carefully on OSP and armored cabling at light tension levels which do not result in any visible cable jacket deformation.
   5. If unarmored fiber is specified without innerduct for any reason, tie wraps are forbidden on that cabling.
   6. Any and all tie wraps used in the project shall be trimmed flush at the locking device using a fully flush cutter tool for safety. Any tie wrap found with a sharp point shall be removed by the Contractor and replaced without additional compensation.

B. Identify all fiber, copper, and coaxial cables that terminate in the telecommunication room as to field location.

   1. Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type; either pre-numbered plastic coated type, numbered to show cable identification. Install within 6" of cable end.
   2. Contractor shall not distinguish between UTP that is initially intended for voice or data use. The structured cabling plant is designed to be flexible and shall be numbered sequentially throughout the building. Room numbers shall not be used in the numbering scheme. For buildings with multiple Telecom Rooms (and/or per floor), an alphanumeric identifier shall identify the telecom room, followed by the sequentially numbered jack. For example, a jack labeled TC-A-001 would terminate in the “A” Telecom Room and be connected to jack 001 on the patch panels.
   3. All field device labeling shall match the telecom room labeling for the corresponding cable.
   4. Jacks shall be numbered sequentially on the patch panel field, beginning at the top left, working across the row to the right, then down to the next row, etc. This will require Contractor to plan the installation and terminate sequentially on both ends through the building rather than terminate randomly which results in confusion for Owner.
   5. When transitioning from one floor to another on a multi-floor installation served out of one telecom room (or a multi-floor section of a larger building), the patch panel at the end of the installation for a particular floor shall have at least 12 open jacks/slots for future growth on that floor. Also, a new patch panel shall always be started for each new floor. This means if a particular floor has 25 jacks (using 24 port patch panels), the Contractor shall leave the second patch panel with 23 openings and start a fresh patch panel for the next floor.

C. After completion, all cables shall be thoroughly tested in accordance with the division 27 Testing and Documentation section.

   1. Contractor shall provide all instruments for testing the cables.
   2. Contractor shall demonstrate in the presence of Owner’s representative that the telecommunications system is complete and operational.
   3. Contractor shall complete and submit the Certificate of System Demonstration.
D. After completion, comprehensive As-Builts will be created and posted in each Telecom Room within 3 days.

1. Two hard copies shall be created for each Telecom Room detailing the entire structured cabling plant and labeling scheme after installation. One hard copy shall consist of (at a minimum) the Telecom plans marked with permanent ink to show the labeling used at each field location, and a table or spreadsheet (for example, an 8 ½” x 11” printed Excel file) that lists all the patch panel jacks in a column sequentially, followed by a cross reference column identifying the room name/number that the corresponding jack is in. This is the only part of the labeling process in which room name/numbers are acceptable. The second hard copy shall be identical to the first one. One copy shall be posted in each corresponding Telecom Room, and the other copy shall be submitted to the Design Professional for review according to the submittal process identified in the shop drawing paragraph of Specification Section 27 00 10. This second copy will then be forwarded to Owner.

END OF SECTION 27 11 00
SECTION 27 12 00 - TELECOMMUNICATIONS TESTING AND DOCUMENTATION

PART 1 - GENERAL

1.01 PURPOSE

A. The purpose of the testing is to ensure proper installation of the telecommunications cabling system.

B. Refer to plans for phasing notes as they relate to delivery of equipment. Contractor must account for appropriate price increases and or secure storage of materials and equipment to comply with phasing requirements.

1.02 SUBMITTALS

A. Submit product data under provisions of Division 1.

B. Submit product data for the following:

1. Hand-held testing equipment manufacturer, model, last calibration date/calibration due date and software version.

2. Injector equipment manufacturer, model, and software version.

1.03 REFERENCES

A. The following Performance Standards shall be followed. Unless otherwise stated, where Performance Standards conflict with manufacturer’s recommendations, the more restrictive shall be applied:

1. TIA-526-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant

2. TIA-526-14 Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant

3. TIA-568-C.0 Generic Telecommunications Cabling For Customer Premises

4. TIA-568-C.1 Commercial Building Telecommunications Cabling Standard

5. TIA-568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standards

6. TIA-568-C.3 Optical Fiber Cabling Components Standard

7. TIA-568-C.4 Broadband Coaxial Cabling and Components Standard

1.04 TEST EQUIPMENT

A. Test Equipment: JDSU Certifier40G, Fluke DSX-5000, Fluke DTX-1800 or TIA & Connectivity Manufacturer approved Level IV (or better) Certifier.

B. The software version for the testers shall be the latest version available.

C. The tester must have been calibrated within the last 12 months with calibration date noted on all test results.

1.05 LINK DEFINITION FOR THE PROJECT

A. A link consists of up to 90 meters (295 feet) of horizontal cabling, a connection at each end, up to 2 meters of test equipment lead from the main unit of the hand-held tester to the local connection, and up to 2 meters of test equipment lead from the remote unit to the remote connection. A total length of up to 94 meters (308 feet).
1.06 CHANNEL DEFINITION FOR THE PROJECT

A. A channel consists of up to 90 meters (295 feet) of horizontal cabling, a connection at each end, up to 7 meters for the cross-connect and equipment cable, and up to 3 meters for the work area equipment cable. A total length of up to 100 meters (328 feet).

B. The connection to the equipment at each end of the channel is not included in the channel definition.

PART 2 - COPPER CABLING ACCEPTANCE TESTING

2.01 ACCEPTANCE TESTS

A. The following field acceptance tests shall be performed for twisted-pair cabling:
   
   1. Wire Map (continuity).
   2. Length.
   3. Attenuation.
   4. NEXT.
   5. ACR-F
   6. Delay and delay skew.
   7. Return loss.
   8. Power sum crosstalk (PSNEXT and PSACR-F).

2.02 TEST EQUIPMENT SET-UP AND TEST PARAMETERS

A. Autotest: Use the Autotests to perform the required tests. Customize the Autotest as necessary to satisfy testing requirements and parameters.

B. Cable Type: Select the cable type being tested. Cable Type may vary. Always change the NVP for the type of cable being tested.

C. Frequency Range: The frequency range for category 6A tests shall be 1 MHz to 500 MHz.

D. Cable Pairs: Test all cable pairs. Select all pairs for TEST and all pairs for Pass/Fail criteria for Autotest.

E. Length Units: Cable length test results shall be in feet.

F. Date Style. The date style shall show month, day, and year. Date shall be the date the test is conducted.

G. Language: The language shall be English.

2.03 TEST PROCEDURE

A. Testing shall be performed with the tester at the distribution frame and the remote unit at the Work Area Outlet.

B. A Channel OR Permanent Link certification test will be performed as outlined in the specific job description.

C. Test leads and test hardware have limited life-cycles. Inspect and replace the test leads as necessary.
D. Use only test leads specified by the test equipment manufacturer.

E. Strictly follow the test equipment manufacturer's instructions for equipment setup, initialization, and calibration.

PART 3 - SINGLEMODE FIBER TESTING

3.01 ACCEPTANCE TESTS

A. The following field acceptance tests shall be performed for single mode fiber:

1. End to end attenuation and length testing at 1310 nm and 1550 nm.

3.02 TEST PARAMETERS

A. The following tests parameters shall be adhered to:

1. The transmit test port & test jumpers must be inspected and (if required) cleaned prior to testing. An image of the endfaces with endface condition pass/fail result must be included with the test report. Endface pass/fail conditions are outlined in TIA-568-C Annex E.

2. Fiber under test endfaces must be inspected and cleaned. An image with pass/fail criteria for endface condition must be included in the test results per TIA-568-C Annex E.

3. Test jumpers must be of the same fiber core size and connector type as the cable system (e.g., singlemode jumpers for a singlemode system).

4. As required in TIA-526-7, The testers must be referenced prior to testing by the one jumper method. The reference method preferred must be noted in the job specifications prior to testing.

5. The power meter and the light source must be set to the same wavelength.

6. The power meter must be calibrated and traceable to the National Institute for Standards and Technologies (NIST).

7. The light source or OTDR must operate within the range of 1310+10 nm or 1550+20nm for singlemode testing in accordance with ANSI/TIA/EIA-526-7.

8. All system connectors, adapters, and jumpers must be properly cleaned before measurements are taken.

PART 4 - TESTING DOCUMENTATION

4.01 DOCUMENTATION

A. The Test Documentation requirements are the minimum requirements. Other details of presentation and recording methods will be discussed with Owner and Design Professional. Gain approval from Owner and Design Professional of the test documentation format and content prior to full-scale testing. Coordinate with Owner and Design Professional to get representative sample of the documentation format and content for review.

B. Provide Owner with a printed copy of ONLY the summary report of all tests, the electronic file of the test results for each test on CD or USB, and the electronic copy of the summary report on CD or USB. Do not print out each report.
4.02 TEST REPORT
A. The following header fields on each test report shall contain the appropriate information. These are minimum requirements.

1. Circuit ID
2. Test Result
3. Owner
4. Test Equipment Serial Number
5. Software Version
6. Calibration Date
7. Date
8. Cable Type
9. NVP
10. Building
11. Closet

B. The information in each user definable header field on each test report shall contain the information as follows.

1. Circuit ID: Indicate the outlet location number and jack number under test
2. Owner: Indicate the owner of the test equipment
3. Date: Indicate the date of the test
4. Cable Type: Indicate the cable type being tested
5. NVP: Indicate the field measured NVP
6. Building: Indicate the building where the cable is being tested
7. Closet: Indicate the closet identifier where the cable is terminated

C. The minimum test result information on each report shall include the data for the tests identified in the Acceptance Tests paragraph of each applicable testing part.

D. Contractor shall provide the test data in a complete and consistent format. Printed test results shall be printed from a laser printer.

E. The contractor shall verify that a report for each jack in the Project is contained in the file list.

F. Two weeks (14 days) prior to scheduled telecommunications systems start-up date Design Professional shall receive from Contractor complete printed cable performance test results via the submittal process (see 27 0010). Start-up shall not commence unless test results are submitted.

4.03 ELECTRONIC COPY
A. The electronic copy of the test results shall be on CD or USB.

B. The electronic copy shall be labeled. The label shall read:

    Project Name
    building name (BLDG. No. x)
    "Copper/Fiber Test Results"
    "CD No." X of X
    date (month and year)

C. The files shall not be altered from the original test equipment output.

END OF SECTION 27 12 00
SECTION 27 40 00 - AUDIOVISUAL SYSTEM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 27 00 10 – Telecommunications General Provisions are applicable to work required of this section.

B. Refer to plans for phasing notes as they relate to delivery of equipment. Contractor must account for appropriate price increases and or secure storage of materials and equipment to comply with phasing requirements.

1.02 DESCRIPTION OF WORK

A. The work included under this specification consists of the Audiovisual Contractor furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this audiovisual system in compliance with the specifications and drawings. The Audiovisual Contractor shall provide and install all of the required material to form a complete system whether specifically addressed in the technical specifications or not.

B. It is not acceptable for any portion of this scope of work (whether cable or material acquisition, or any labor to install said cable or materials) to be performed by the Electrical Contractor or any other contractor other than the acceptable bidders selected from the requirements in paragraph 1.07 ACCEPTABLE AUDIOVISUAL CONTRACTORS below who have demonstrated the necessary technical and professional capabilities for the work required.

1.03 SUBMITTALS

A. Submittal data for audiovisual cabling and components shall consist of catalog product sheets showing technical data necessary to evaluate the materials and also one line diagrams showing the intended signal flow throughout.

1.04 EQUIPMENT OBSOLESCENCE AND MANUFACTURER REPLACEMENTS

A. Electronic equipment of all types (audiovisual included) is a fast paced industry with ever changing technology. Products are often specified by manufacturer and model number but can become obsolete during extended construction timeframes. The Audiovisual Contractor shall be responsible for providing either the equipment specified or the manufacturer approved replacement for the specified item (despite potential price increases or decreases). Submittals for replacement items shall be submitted through channels as soon as possible after the item is discovered. The Audiovisual Contractor shall plan accordingly as cost adding change orders for equipment obsolescence items will not be approved.

1.05 WORK BY OTHERS

A. Unless noted otherwise, the building’s Electrical Contractor will provide field device backboxes, and conduit paths for use by Contractor. In general, the following is provided:

1. Electrical Contractor will make 120VAC connections for the motorized screen and switch (if applicable).
2. General Contractor will mount the screen housing (if recessed in ceiling).
1.06 FIRESTOPPING
A. Contractor shall be responsible for firestopping all conduit sleeves and cable tray where required to maintain integrity of fire walls. Contractor shall see architectural drawings for walls that require fire rating.

1.07 ACCEPTABLE AUDIOVISUAL CONTRACTORS
A. The contractor shall be one of the following:
   1. Communications Engineering Company (CEC), Hiawatha, Iowa (319) 294-9000, contact Cecil Anderson
   2. Conference Technologies, Inc. (CTI), Hiawatha Iowa (319) 363-8144, Contact Nathan Reasner
   3. DB Acoustics, Marion Iowa (319) 373-1425, contact Jim Gnagy
   4. ECS Technologies Inc., Davenport Iowa (563) 322-1525, contact Nate Lawrence

B. The contractor looking for a bid from the contractors listed above shall contact them as soon as possible to ensure they are aware of the project and have adequate time to prepare a bid. Two weeks should be considered a minimum.

PART 2 - PRODUCTS

2.01 PROJECTION SCREENS
A. Projection Screens shall be provided with all applicable accessories as a system.

B. Acceptable Manufacturers:
   1. Provide per plans and Audiovisual Equipment Schedule.

C. Additional Projection Screen Requirements:
   1. Where AV control systems are utilized, connect low voltage portion of screens to the control system.

2.02 FLAT PANEL DISPLAYS
A. Flat Panel Displays shall be provided with all applicable accessories as a system.

B. Flat Panel Displays refers to any space that is utilizing a single display to produce the complete image. Specifications for the video wall are found further down this specification.

B. Acceptable Manufacturers:
   1. Provide per plans and Audiovisual Equipment Schedule.

C. Additional Flat Panel Display Requirements:
   1. For inputs where a laptop or desktop computer is connected, displays shall be configured in a manner that utilizes the least amount of extraneous video processing (i.e. 'Game Mode') as to reduce input lag from keyboards, mice, and other peripherals.
   2. For classrooms and conference rooms, remote controls shall be left in those spaces where AV control systems are not present.
   3. Associated remote control shall be left in the Booster Concession area.
2.03 PROJECTORS

A. Projectors shall be provided per plans and specifications.

B. Acceptable Manufacturers:
   1. Provide per plans and Audiovisual Equipment Schedule.

C. Additional Projector Requirements:
   1. In spaces with 16:9 screens, projectors shall be aimed and configured to operate in 16:9 mode.
   2. Projector remote controls shall be left in those classrooms where AV control systems are not present.

2.04 AUDIO SOUND SYSTEMS

A. The audio sound system consists of the microphones & their associated peripherals, the audio mixer, signal processing, amplification, and loudspeakers.

B. Sound systems shall be provided with all applicable components, connectors, and accessories as a complete system.

C. Acceptable Manufacturers:
   1. Provide per plans and Audiovisual Schedule.

D. Additional Sound System Requirements:
   1. Audio Sound Systems shall be configured in a manner consistent with Infocomm's Standard for Audio Coverage Uniformity in Enclosed Listener Spaces.
   2. Microphones, mixing, and signal processing shall be configured to operate as local voice reinforcement.
   3. Microphones shall be installed in a manner that does not interfere with use of the respective room or work area.
   4. Wired microphones for Band, Choir, and Mirror rooms shall be turned over to Band staff upon completion of microphone configuration in those areas.
   5. In spaces utilizing AV control system touch panels, all microphone levels shall be adjustable via the touch panel. See Control Systems further down this specification.

2.05 CABLING FOR AUDIO AND VIDEO

A. All cabling for audio and video devices shall be furnished and installed by the Audiovisual System Contractor as required for a complete and operational system. Special cable assemblies shall be furnished and installed as specified on the plans, but all bulk cabling (speaker wire, field terminated “back of rack” cabling, shielded microphone cable, etc.) shall be furnished as listed below.

B. Acceptable Manufacturers:
   1. For pre-assembled cable assemblies or specialty cabling items, furnish as specified on plans.
   2. For all bulk cabling, furnish Belden cabling.
C. Additional Cabling Requirements:

1. Use plenum rated cabling when required for HVAC system in the space, or when directly specified.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install audiovisual systems cables, equipment, and auxiliary materials as indicated in accordance with manufacturer's written instructions, and recognized industry practices.

1. Hook and loop type fasteners are preferred on all audiovisual cable. Tie wraps are acceptable if the Contractor uses them in a way that does not damage the cable (do not over-tighten), plus uses flush cut diikes (side cutters) to trim all tie wrap tails off flush with the connector body. Regular diikes or other cutters are not acceptable and pose a danger to all who may come in contact with the improperly trimmed tie wraps. Failure to follow this safety requirement (or the proper installation requirement regarding damage to cables) shall result in the Contractor removing all tie wraps and replacing them with hook and loop type fasteners. The Contractor shall be responsible for replacing any cable that does not perform properly and/or is damaged due to improper use of tie wraps.

2. Contractor shall use provided raceways or Contractor install J-hooks for all cabling. No fastening cabling to conduits, piping, equipment, or anything other than Contractor installed J-hooks.

B. Identify all audiovisual cables as to field location.

1. Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type; either pre-numbered plastic coated type, or write-on type with clear plastic self-adhesive cover flap; numbered to show cable identification. Install within 6" of cable end.

C. After completion, all cables shall be thoroughly tested.

1. Contractor shall provide all instruments for testing the cables.
2. Contractor shall demonstrate in the presence of Owner's representative that the audiovisual system is complete and operational.
3. Contractor shall complete and submit the Certificate of System Demonstration.

D. After completion, comprehensive As-Builts will be created and provided to Owner within 3 days.

1. Two hard copies shall be provided to Owner detailing the entire audiovisual system after installation. Each field position shall be labeled and cross referenced to the appropriate head end position for ease of troubleshooting.

3.02 FUNCTIONAL TESTING

A. The Contractor shall coordinate a date/time with the Engineer after the system is fully operational, but before final payment, for the Contractor to provide a full system demonstration. This shall include all aspects of system operation that the user might encounter. The following spaces shall have functional tests:

1. Typical Classroom
2. Conference Room

END OF SECTION 27 40 00
SECTION 27 50 00 - INTERCOM SYSTEM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 27 00 10 – Telecommunications General Provisions are applicable to work required of this section.

B. Refer to plans for phasing notes as they relate to delivery of equipment. Contractor must account for appropriate price increases and or secure storage of materials and equipment to comply with phasing requirements.

1.02 DESCRIPTION OF WORK

A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this intercom system in compliance with the specifications and drawings. Contractor will provide and install all of the required material to form a complete system whether specifically addressed in the technical specifications or not.

1.03 SUBMITTALS

A. Submittal data for intercom cabling and components shall consist of catalog cuts showing technical data necessary to evaluate the materials.

1.04 WORK BY OTHERS

A. Unless noted otherwise, the building’s Electrical Contractor will provide field device backboxes if needed, and conduit paths for use by Contractor.

1.05 FIRESTOPPING

A. Contractor shall be responsible for firestopping all conduit sleeves and cable tray where required to maintain integrity of fire walls. Contractor shall see architectural drawings for walls that require fire rating.

1.06 ACCEPTABLE INTERCOM CONTRACTORS

A. The intercom contractor shall be:

   1. Rauland is a protected dealership therefore the only acceptable Contractor is the local Rauland dealer which is CEC in Hiawatha Iowa. Contact Cecil Anderson at (319) 294-9000 (no other CEC office for this project, only Hiawatha Iowa).

PART 2 - PRODUCTS

2.01 INTERCOM SYSTEMS

A. Intercom systems shall be provided with all applicable accessories as a system.

B. Acceptable Manufacturers:

   1. Rauland Campus Controller IP Intercom System
C. Additional Requirements:
   1. Each classroom shall be a separate zone.
   2. Each office area shall be a separate zone.
   3. Other staff spaces (conference rooms, etc.) shall each be a separate zone (not mechanical spaces).
   4. All other areas shall have coverage for paging purposes.
   5. Rauland 2’x2’ tile replacement speakers shall be used in accessible ceiling spaces whenever possible.
   6. Rauland equivalent of Quam System 1 with Rauland RJ45 jack connection may be used in interior standard volume surface mount installation.

2.02 VIDEO INTERCOM SYSTEMS

A. Point to point dedicated Video Intercom systems shall be provided with all applicable accessories as a system.

B. Acceptable Manufacturers:
   1. Aiphone (per plans)

C. Additional Requirements: none

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install intercom systems cables, equipment, and auxiliary materials as indicated in accordance with manufacturer's written instructions, and recognized industry practices.
   1. Contractor shall use hook and loop type fasteners on all intercom cable. Tie wraps shall not be used.
   2. Contractor shall use provided raceways or Contractor install J-hooks for all cabling. No fastening cabling to conduits, piping, equipment, or anything other than Contractor installed J-hooks.
   3. All intercom cabling shall be homerun, no splicing.

B. Identify all intercom cables as to field location.
   1. Provide manufacturer’s standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type; either pre-numbered plastic coated type, or write-on type with clear plastic self-adhesive cover flap; numbered to show cable identification. Install within 6” of cable end.

C. After completion, all cables shall be thoroughly tested.
   1. Contractor shall provide all instruments for testing the cables.
   2. Contractor shall demonstrate in the presence of Owner's representative that the intercom system is complete and operational.
   3. Contractor shall complete and submit the Certificate of System Demonstration.

D. After completion, comprehensive As-Builts will be created and provided to Owner within 3 days.
   1. Two hard copies shall be provided to Owner detailing the entire intercom system after installation. Each field position shall be labeled and cross referenced to the appropriate
head end position for ease of troubleshooting.

3.02 COMMISSIONING

A. The Contractor shall coordinate a date/time with the Engineer after the system is fully operational, but before final payment, for the Contractor to provide a full system demonstration. This shall include all aspects of system operation that the user might encounter.

END OF SECTION 27 50 00
SECTION 27 60 00 - SCHOOL CLOCK SYSTEM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS
A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 27 00 10 – Telecommunications General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK
A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this school clock system in compliance with the specifications and drawings. Contractor will provide and install all of the required material to form a complete system whether specifically addressed in the technical specifications or not.

1.03 SUBMITTALS
A. Submittal data for clock system and components shall consist of catalog cuts showing technical data necessary to evaluate the materials.

PART 2 - PRODUCTS

2.01 SCHOOL CLOCK SYSTEM
A. The clock system shall be provided with all applicable accessories as a system.

B. Acceptable Manufacturers:
1. American Time

C. Additional Clock System Requirements:
1. All devices in gymnasiums or other designated play areas shall have wire guards.
2. The Contractor shall not add or include their or any other company name or logo on the clock face. The manufacturer name/logo which comes complete with each clock is the only thing acceptable on the clock unless the Owner chooses to add their school name or logo (still no contractor name or logo will be allowed). Clocks not conforming to this requirement shall be fully replaced at the Contractors expense.
3. Provide and install per additional requirements found on the plans
4. The Contractor shall confirm and coordinate with the clock manufacturer for proper transmitter and clock specifications to receive this signal.
   a. FREQ - 464.650
   b. Legacy Time Code = 0800824
   c. Event Cap Code = 0800812

PART 3 - EXECUTION

3.01 INSTALLATION
A. Install school clock system cables, equipment, and auxiliary materials as indicated in accordance with manufacturer's written instructions, and recognized industry practices.

1. Contractor shall use hook and loop type fasteners on all cable. Tie wraps shall not be used.
2. Contractor shall use provided raceways or Contractor installed J-hooks for all cabling. No fastening cabling to conduits, piping, equipment, or anything other than Contractor installed J-hooks.

B. Identify all system cables as to field location.

1. Provide manufacturer’s standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type; either pre-numbered plastic coated type, or write-on type with clear plastic self-adhesive cover flap; numbered to show cable identification. Install within 6” of cable end.

C. After completion, all cables shall be thoroughly tested.

1. Contractor shall provide all instruments for testing the cables.
2. Contractor shall demonstrate in the presence of Owner's representative that the school clock system is complete and operational.
3. Contractor shall complete and submit the Certificate of System Demonstration.

D. After completion, comprehensive As-Builts will be created and provided to Owner within 3 days.

1. Two hard copies shall be provided to Owner detailing the entire school clock system after installation. Each field position shall be labeled and cross referenced to the appropriate head end position for ease of troubleshooting.

3.02 COMMISSIONING

A. The Contractor shall coordinate a date/time with the Engineer after the system is fully operational, but before final payment, for the Contractor to provide a full system demonstration. This shall include all aspects of system operation that the user might encounter.

END OF SECTION 27 60 00
SECTION 28 00 10 - ELECTRONIC SAFETY AND SECURITY GENERAL PROVISIONS

PART 1 - GENERAL

1.01 GENERAL

A. Refer to Division 00 - Procurement and Contracting Requirements and Division 01 - General Requirements, which all apply to work under this section.

B. Project is a multi-year phased project. Refer to plans for phasing notes as they relate to delivery of equipment. Contractor must account for appropriate price increases and or secure storage of materials and equipment to comply with phasing requirements.

1.02 DESCRIPTION OF WORK

A. This section applies to all work under this division. This shall include, but not necessarily be limited to, the following:

1. Furnish, install, and terminate all system equipment and cabling as applicable and per drawings.
2. Furnish and install any cabinets, racks and cable management as required and as indicated.
3. Furnish any other material required to form a complete and operational system.
4. Provide As-Built drawings per Division 0 and/or Division 1 specification.
5. Provide Owner training and testing documentation.
6. All elements of the construction shall be performed by workmen skilled in the particular craft involved, and regularly employed in that particular craft.
7. All work shall be performed in a neat, workmanlike manner in keeping with the highest standards of the craft.

1.03 CODES AND STANDARDS

A. All work shall be done in accordance with the applicable portion of the following codes and standards:

1. National Electrical Code 2014
2. Local Electrical Code
3. National Fire Protection Association
4. National Electrical Manufacturers Association
5. Standards of Institute of Electrical and Electronic Engineers
6. Applicable Building Codes
7. Occupational Safety and Health Act
8. Iowa Administrative Codes
10. ANSI TIA-526-14-C Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
11. ANSI TIA-568-C.0 Generic Telecommunications Cabling For Customer Premises
13. ANSI TIA-568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standards
14. ANSI TIA-568-C.3 Optical Fiber Cabling Components Standard
15. ANSI TIA-568-C.4 Broadband Coaxial Cabling and Components Standard
16. ANSI TIA-569-D Telecommunications Pathways and Spaces
17. ANSI TIA-570-C Residential Telecommunications Infrastructure Standard
18. ANSI TIA-598-D Optical Fiber Cable Color Coding
19. ANSI TIA-606-B Administration Standard for Commercial Telecommunications Infrastructure
20. ANSI TIA-607-B Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
21. ANSI TIA-758-B Customer-owned Outside Plant Telecommunications Infrastructure Standard
22. National Fire Protection Agency (NFPA - 70), National Electrical Code (NEC)

B. All Contractors shall familiarize themselves with all codes and standards applicable to their work. No extra compensation will be allowed for corrections or changes in the work required due to failure to comply with the applicable codes and standards. Where two or more codes or standards are in conflict, that requiring the highest order of workmanship shall take precedence, but such questions shall be referred to Design Professional for final decision.

1.04 REQUIREMENTS & FEES OF REGULATORY AGENCIES

A. Contractor shall comply with the rules and regulations of the local serving utility companies and shall check with each utility company providing service to this project and determine or verify their requirements regarding incoming services.

B. Secure and pay for all permits, licenses, fees and inspections.

1.05 DRAWINGS

A. Drawings for the work are in part diagrammatic, and are intended to convey the scope of the work and to indicate in general the location of equipment.

B. Contractor shall layout his own work and shall be responsible for determining the exact quantities and locations for equipment.

C. Contractor shall take own field measurements for verifying locations and dimensions; scaling of the drawings will not be sufficient for laying out the work.

D. Because of the scale of the drawings, certain basic items for a complete installation are not shown, but where such items are required by code or where they are required for proper installation and operation of the work, such items shall be furnished and installed.

1.06 ACTIVE SERVICES

A. Contractor shall be responsible for verifying exact locations of all existing services prior to beginning work in that area.

B. When active services are encountered which require relocation, Contractor shall make request to authorities with jurisdiction for determination of procedures.

C. Where existing services are to be abandoned, they shall be terminated in conformance with requirements of the authorities having jurisdiction.

1.07 SITE INSPECTION

A. Contractor shall inspect the site prior to submitting bid for work to become familiar with the conditions of the site which will affect the work and shall verify points of connection with utilities and/or existing system wiring.

B. Extra payment will not be allowed for changes in the work required because of Contractor's failure to make this inspection.
1.08 COORDINATION AND COOPERATION

A. It shall be the Contractor's responsibility to schedule and coordinate work with the schedule of the General Contractor so as to progress the work expeditiously, and to avoid unnecessary delays.

B. Contractor shall fully examine the drawings and specifications for other trades and shall coordinate the installation of his work with the work of the other contractors. Contractor shall consult and cooperate with the other contractors for determining space requirements and for determining that adequate clearance is allowed with respect to his equipment, other equipment and the building. The Design Professional reserves the right to determine space priority of the contractors in the event of interference between piping, conduit, ducts and equipment of the various contractors.

C. Conflicts between the drawings and the specifications, or between the requirements set forth for the various divisions shall be called to the attention of the Design Professional. If clarification is not asked for prior to the taking of bids, it will be assumed that none is required and that the Contractor is in agreement with the drawings and specifications as issued. If clarification is required after the contract is awarded, such clarification will be made by the Design Professional and the decision will be final.

D. Special care shall be taken for protection for all equipment. All equipment and material shall be completely protected from weather elements, painting, plaster, etc., until the project is substantially completed. Damage from rust, paint, scratches, etc., shall be repaired as required to restore equipment to original condition.

E. Protection of all equipment during the painting of the building shall be the responsibility of the Painting Contractor, but this shall not relieve the Contractor of the responsibility for checking to assure that adequate protection is being provided.

F. Where the final installation or connection of equipment in the building requires the Contractor to work in areas previously finished by the Owner, the Contractor shall be responsible that such areas are protected and are not marred, soiled or otherwise damaged during the course of such work. Contractor shall be responsible for patching and refinishing of such areas which may be damaged in this respect.

G. Where two or more specified items/systems in the specifications and/or the drawings are in conflict, that requiring the highest order of workmanship and the most financially expensive products shall take precedence. Such questions shall be referred to the Design Professional for final decision.

1.09 MATERIALS AND EQUIPMENT

A. All materials and equipment shall be the standard product of a reputable manufacturer regularly engaged in the manufacture of the specified item unless authorized in writing by Design Professional. Where more than one unit is required of the same items, they shall be furnished by the same manufacturer except where specified otherwise.

B. All material and equipment shall be installed in strict accordance with the manufacturer's recommendations.

C. The equipment specifications cannot deal individually with any minute items such as parts, controls, devices, etc., which may be required to produce the equipment performance and function as specified, or as required to meet the equipment guarantees. Such items when required shall be furnished as part of the equipment, whether or not specifically called for.
1.10 SHOP DRAWINGS

A. Contractor shall furnish, to the Design Professional, complete sets of shop drawings and other submittal data. Contractor shall review and sign shop drawings before submittal.

B. Shop drawings shall be bound into sets and cover related items for a complete system as much as practical and shall be identified with symbols or "plan marks" used on drawings. Incomplete, piecemeal or unbound submittals will be rejected.

C. The Design Professional will review shop drawings solely to assist contractors in correctly interpreting the plans and specifications.

D. Contract requirements cannot be changed by shop drawings which differ from contract drawings and specifications.

E. Submittals required by the various sections of the Project Manual include, but are not necessarily limited to those identified in the submittal schedule below.

F. After award of contract, the contractor shall provide a completed submittal schedule including dates that the submittals will be to the Design Professional for review.

G. Submit required information on the following items:

<table>
<thead>
<tr>
<th>SPEC SECTION</th>
<th>EQUIPMENT</th>
<th>DETAIL DWGS</th>
<th>PROD DATA</th>
<th>SAMPLES</th>
<th>INSTALL METHODS</th>
<th>O &amp; M MANUAL</th>
<th>CERTIFICATE OF SYSTEM DEMONSTRATION</th>
<th>OTHER (SEE NOTES)</th>
</tr>
</thead>
<tbody>
<tr>
<td>28 31 00</td>
<td>Fire Alarm</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28 50 00</td>
<td>Access Control</td>
<td>X</td>
<td>X X</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>28 60 00</td>
<td>Video Surveillance</td>
<td>X</td>
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<td>X</td>
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Notes:

1.11 OPERATION AND MAINTENANCE MANUALS

A. Operation and maintenance manuals shall be submitted to the Design Professional in duplicate upon completion of the job. Manuals shall be bound in a three ring hard-backed binder. Front cover and spine of each binder shall have the following lettering done:

OPERATION AND MAINTENANCE MANUAL FOR TELECOMMUNICATIONS SYSTEMS

(PROJECT NAME) (LOCATION) (DATE)

SUBMITTED BY (NAME, ADDRESS AND PHONE NUMBER OF CONTRACTOR)

B. Provide a master index at the beginning of manual showing items included. Each section shall contain the following information for equipment furnished under this contract:

1. Equipment and system warranties and guarantees.
2. Installation instructions.
3. Operating instructions.
5. Spare parts identification and ordering list.
6. Local service organization, address, contact and phone number.
7. Shop drawings with reviewed stamp of Design Professional and Contractor shall be included, if applicable, along with the items listed above.

1.12 TESTS AND DEMONSTRATIONS

A. All systems shall be tested by the Contractor and placed in proper working order prior to demonstrating systems to Owner.

1.13 TRAINING AND DEMONSTRATIONS

A. Prior to acceptance of the telecommunications installation, the Contractor shall provide to the Owner, or his designated representatives, all comprehensive training on essential features and functions of all systems installed, and shall instruct the Owner in the proper operation and maintenance of such systems.

1. Provide adequate notice to the Owner as to when instruction will be conducted so appropriate personnel can be present.
2. Prepare the instruction format for a minimum of four Owner Representatives.

B. Equipment training:

1. Manufacturer's representatives shall provide instruction on each major piece of equipment. The Contractor shall provide instruction on all other equipment.
2. Training sessions shall use the printed installation, operation and maintenance instruction materials included in the O&M manuals and emphasize preventative maintenance and safe operating procedures.
3. Training shall be performed by qualified factory trained technicians.
4. The Contractor shall attend all sessions performed by the manufacturer's representative and shall add to each session any special information relating to the details of installation of the equipment as it might impact the operation and maintenance.
5. Equipment training shall occur as soon as possible after start up of the equipment and shall include hands-on operation. Training shall be provided for equipment listed in the table below.

C. System training:

1. Training sessions shall include hands-on demonstrations of system wide start-up, operation in all possible modes, shut-down and emergency procedures.

D. The following are minimum requirements for Owner instruction:

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Hrs. on Site</th>
<th>Hrs. off Site</th>
<th>Presented By</th>
<th>Others Present</th>
<th>Remarks</th>
</tr>
</thead>
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<tr>
<td>28 31 00</td>
<td>Fire Alarm</td>
<td>8</td>
<td>0</td>
<td>Fire Alarm Vendor</td>
<td>Contractor</td>
<td>1</td>
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<tr>
<td>28 50 00</td>
<td>Access Control</td>
<td>2</td>
<td>0</td>
<td>Access Control Contractor</td>
<td>Contractor</td>
<td>1</td>
</tr>
<tr>
<td>28 60 00</td>
<td>Video Surveillance</td>
<td>2</td>
<td>0</td>
<td>Video Surveillance Contractor</td>
<td>Contractor</td>
<td>1</td>
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</table>

Remarks:

1. Perform complete system test at time of instruction.

E. The Contractor shall submit a certificate, signed by the Owner stating the date, time and persons instructed and that the instruction has been completed to the Owner’s satisfaction. An example of a certificate form is as follows:
CERTIFICATE OF SYSTEM DEMONSTRATION

This document is to certify that the contractor has demonstrated the hereafter listed systems to the Owner's representatives in accordance with the Contract documents and that the instruction has been completed to the Owner's satisfaction.

A. Project:

B. System(s):

C. Contractor's representatives giving instruction and demonstration:

Contractor: _______________________________

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<th>NAMES</th>
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D. Owner's representatives receiving instruction:

Owner: _______________________________

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<tr>
<th>NAMES</th>
<th>DATE</th>
<th>HOURS</th>
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</table>

Acknowledgement of demonstration:

E. Contractor's Representative:

signature

date

Owner's Representative:

signature

date

ELECTRONIC SAFETY AND SECURITY GENERAL PROVISIONS 28 00 10 - 6
1.14 PERMITS, FEES, ETC.
A. Secure all required permits and pay for all inspections required in connection with the telecommunication systems work. Contractor shall post all bonds and obtain all licenses required by the State, City, County, and Federal Agencies.

1.15 SUBSTITUTIONS
A. To obtain approval to use unspecified equipment, Bidding Contractors (not equipment supplier, manufacturers, etc.) shall submit written requests to the Design Professional at least 10 days prior to bid due date. Requests shall clearly describe the equipment for which approval is being requested. Include all data necessary to demonstrate that equipment's capacities, features and performance are equivalent to include a cost comparison between specified equipment and equipment for which approval is being requested. If the equipment is acceptable, the Design Professional will approve it in an addendum. The Design Professional will, under no circumstances, be required to prove that an item proposed for substitution is or is not of equal quality to the specified item.

B. Where substitutions are approved, Contractor assumes all responsibility for physical dimensions and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of the substitution.

1.16 APPROVED CONTRACTORS
A. The Contractor shall be a manufacturer certified installer and service provider for the product submitted and installed. A copy of the Contractor's manufacturer certification must be submitted under this specification section for the Access Control Contractor and the Video Surveillance Contractor if applicable to the project. The Contractor is responsible for workmanship and installation practices in accordance with the manufacturer requirements and must be authorized to provide a Manufacturer's Product Warranty with his installation.

B. The Contractor pulling the cabling (if different from the prime system Contractor) shall meet the BICSI or IBEW/NECA requirements found in the Division 27 General Provisions.

C. Contractor shall be located within 125 miles of the construction site to establish a potential two-hour response time for ongoing customer needs after construction completion.

1.17 ACCEPTABLE MANUFACTURERS
A. In most cases, equipment specifications are based on a specific manufacturer's type, style, dimensional data, catalog number, etc. Listed with the base specification, either in the manual or on the plans are acceptable manufacturers approved to bid products of equal quality. These manufacturers are encouraged to submit to the Design Professional at least 8 days prior to the bid due date drawings and catalog numbers of products to be bid as equals.

B. Manufacturers who do not submit prior to bidding run the risk of having the product rejected at time of shop drawing submittal. Extra costs associated with replacing the rejected product shall be the responsibility of the Contractor and/or the manufacturer.

C. If the Contractor chooses to use a manufacturer listed as an equal, it shall be his responsibility to assure that the manufacturer has complied with the requirements in 'A' above. Contractor shall assume all responsibility for physical dimensions, operating characteristics, and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of using the alternate manufacturer.
D. Where a model or catalog number is provided, it may not be inclusive of all product requirements. Refer to additional requirements provided on the plans or in the specifications as required. Similarly, there may be additional requirements included in the model or catalog number that are not specifically stated. These requirements shall also be met.

1.18 QUALITY ASSURANCE

A. The Contractor shall be a company specializing in telecommunication cable and/or accessories with a minimum of five years documented experience in installation of cable and/or accessories similar to those specified below.

1.19 WARRANTY

A. The entire telecommunications system including all sub-systems shall be guaranteed against defect in materials and installation for a minimum of one year. Any malfunctions which occur within the guarantee period shall be promptly corrected without cost to the Owner. This guarantee shall not limit or void any manufacturer's express or implied warranties.

1.20 CHANGES IN THE WORK

A. A Contract Change Order is a written order to the Contractor signed by the Owner and Contractor, issued after the execution of the Contract, authorizing a change in the Work or an adjustment in the Contract Sum or the Contract Time. The Contract Sum and the Contract Time may be changed only by Contract Change Order.

B. The Owner, without invalidating the Contract, may order changes in the Work within the general scope of the Contract consisting of additions, deletions or other revisions, with the Contract Sum and the Contract Time being adjusted accordingly. All such changes in the Work shall be authorized by Contract Change Order and shall be performed under the applicable conditions of the Contract Documents.

C. The cost or credit to the Owner resulting from a change in the Work shall be determined by mutual acceptance of a lump sum properly itemized and supported by sufficient substantial data to permit evaluation. Change Orders shall be submitted with each item listed individually with a material cost and labor unit extension. Overhead and profit, as mutually agreed upon between Owner and Contractor shall be added to material and labor cost figures.

D. It shall be the responsibility of the Contractor before proceeding with any change to satisfy himself that the change has been properly authorized on behalf of the Owner.

1.21 COMPLETION

A. Systems, at time of completion, shall be complete, efficiently operating, non-hazardous and ready for normal use by the Owner.

B. When all the work is complete the Contractor shall thoroughly clean all material and equipment installed as a part of this contract and leave all equipment and material in new condition.

C. The Contractor shall clean up and remove from the site all debris, excess material and equipment left during the progress of this contract at job completion.

END OF SECTION 28 00 10
SECTION 28 31 00 - FIRE ALARM AND DETECTION SYSTEM (ADDRESSABLE)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 28 00 10 - Fire Alarm General Provisions are applicable to work required of this section.

B. Project is a multi-year phased project. Refer to plans for phasing notes as they relate to delivery of equipment. Contractor must account for appropriate price increases and or secure storage of materials and equipment to comply with phasing requirements.

1.02 QUALITY ASSURANCE


B. NEC Compliance: Comply with NEC as applicable to construction and installation of fire alarm and detection system components and accessories.

C. UL Compliance and Labeling: Provide fire alarm and detection system components which are UL-listed and labeled.

D. FM Compliance: Provide fire alarm and detection systems and accessories which are FM-approved.

1.03 SUBMITTALS

A. Submittal data for the fire alarm equipment shall consist of shop drawings showing line diagrams, full size drawings with device locations and addresses, quantities of equipment, catalog cuts showing technical data necessary to evaluate the equipment and other descriptive data necessary to describe fully the equipment proposed. Submittal shall be in compliance with all requirements for NFPA 72-2010, 10.18. Submittals shall show approval from Engineer.

B. Provide manufacturers data sheets for Instruments used to test for intelligibility as well as referenced intelligibility scale (STI or CIS)

C. In no instance shall the contract drawings be reproduced for shop drawing submittals.

D. In addition to the engineer, submittals shall be reviewed and approved by the City of Cedar Rapids.

E. Contractor is responsible for any fees associated with the review and approval of the fire alarm drawings and product data by the City of Cedar Rapids. Contractor is also responsible for completion of the required fire alarm system submittal form and submittal of the final fire alarm shop drawings to the Fire Marshall.
1.04 RECORD DRAWING REQUIREMENTS

A. Record drawings shall be provided prior to the time of scheduling of the final inspection. They shall include the location of the overcurrent protection that feeds any fire alarm related equipment and shall be clearly marked on the drawings. Include changes made during system testing and acceptance.

1. The following should be included:
   a. Alarm initiation devices with addresses.
   b. Alarm signal devices with module locations/addresses and circuit numbers.
   c. Door holders and smoke dampers with module location and addressed.
   d. Air handling units with module and relay locations and addresses.
   e. Junction pull boxes.
   f. Layout of conduit with circuit identification.
   g. 120 VAC power sources for control panels, door holders, and fire/smoke dampers.
   h. Location of all end of line resistors.
   i. Calculations for voltage drop on circuits, battery, and audio amplifier sizing.

1.05 SYSTEM OPERATION

A. Control of System: By the Fire Alarm Control Panel.

B. System Supervision: Automatically detect and report open circuits, shorts, and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.

C. Priority of Signals: Automatic alarm response functions resulting from an alarm signal from one zone or device are not altered by subsequent alarm, supervisory, or trouble signals. An alarm signal is the highest priority. Supervisory and trouble signals have second- and third-level priority. Higher-priority signals take precedence over signals of lower priority, even when the lower-priority condition occurs first. Annunciate and display all alarm, supervisory, and trouble signals regardless of priority or order received.

D. Noninterference: A signal on one zone shall not prevent the receipt of signals from other zones.

E. System Reset: All zones are manually resettable from the Fire Alarm Control Panel after initiating devices are restored to normal. Equipment that has been by-passed in software shall not change state of condition during a "reset".

1. Fire Alarm Control Panel shall be reprogrammed so that it can be reset only when a security level access level of 3 or greater is used.

F. Transmission to Remote Alarm Receiving Station: Automatically route alarm, supervisory, and trouble signals to a remote alarm station by means of a digital alarm communicator transmitter and telephone lines.

G. Circuits shall be Class B.

H. Loss of primary power at the Fire Alarm Control Panel initiates a trouble signal at the Fire Alarm Control Panel and the annunciator. An emergency power light is illuminated at both locations when the system is operating on the secondary power supply.

I. Basic Alarm Performance Requirements: Unless otherwise indicated, operation of a manual station, automatic alarm operation of a smoke or flame or heat detector, or operation of a sprinkler flow device initiates the following:

1. Notification-appliance operation.
2. Identification at the Fire Alarm Control Panel and the remote annunciator of the device originating the alarm.
3. Transmission of an alarm signal to the remote alarm receiving station.
4. Release of fire and smoke doors held open.
5. Release of fire and smoke doors held open if a detector adjacent to the door is in alarm.
6. Shutdown of fans and other air-handling equipment serving the fire zone where alarm was initiated.
7. Initiation of smoke control sequence(s).
8. Closing of smoke dampers in air ducts of system serving the fire zone where alarm was initiated.
9. Recording of the event in the system memory.

J. Alarm Silencing, System Reset and Indication: Controlled by switches in the Fire Alarm Control Panel and the remote annunciator.
1. Silencing-switch operation halts alarm operation of notification appliances and activates an "alarm silence" light. Display of identity of the alarm zone or device is retained.
2. Subsequent alarm signals from other devices or fire zones reactivate notification appliances until silencing switch is operated again.
3. When alarm-initiating devices return to normal and system reset switch is operated, notification appliances operate again until alarm silence switch is reset.

K. Smoke detection for zones or detectors with alarm verification initiates the following:
1. Audible and visible indication of an "alarm verification" signal at the Fire Alarm Control Panel.
2. Activation of a listed and approved "alarm verification" sequence Fire Alarm Control Panel and the detector.
3. General alarm if the alarm is verified.
4. Cancellation of the Fire Alarm Control Panel indication and system reset if the alarm is not verified.

L. Sprinkler valve-tamper switch operation initiates the following:
1. A supervisory, audible, and visible "valve-tamper" signal indication at Fire Alarm Control Panel and the annunciator.
2. Transmission of supervisory signal to remote alarm receiving station.

M. Remote Detector Sensitivity Adjustment: Manipulation of controls at the Fire Alarm Control Panel causes the selection of specific addressable smoke detectors for adjustment, display of their current status and sensitivity settings, and control of changes in those settings. Same controls can be used to program repetitive, scheduled, automated changes in sensitivity of specific detectors. Sensitivity adjustments and sensitivity-adjustment schedule changes are recorded in system memory and are printed out by the system printer.

N. Removal of an alarm-initiating device or a notification appliance initiates the following:
1. A "trouble" signal indication at the Fire Alarm Control Panel and the annunciator for the device or zone involved.
2. Transmission of trouble signal to remote alarm receiving station.

O. Fire Alarm Control Panel Alphanumeric Display: Plain-English-language descriptions of alarm, supervisory, and trouble events; and addresses and locations of alarm-initiating or supervisory devices originating the report. Display monitoring actions, system and component status, system commands, programming information, and data from the system's historical memory.
1. The upper line of the display shall indicate the zone in alarm according to the zone schedule on drawings.
2. The lower line of the display shall indicate the address of the device in alarm.

P. LED Lights:
1. Only fire alarm zone lights and "device type" lights shall annunciate with a red LED. Device
type, address and exact location shall annunciate on the digital readout.

2. Any by-pass, disable, or trouble condition shall annunciate with an amber LED, a trouble sounder and annunciate on the digital readout. A “trouble pending” control module shall be included.

1.06 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Strobe Units: 5 units, field selectable 15 to 110CD.
2. Combination Speaker Strobe, Wall Mounted: 5 units, adjustable tap rating of ¼ Watt to 2 Watts, strobe output field selectable 15 to 110CD.
3. Combination Speaker Strobe, Ceiling Mounted: 5 units, adjustable tap rating of ¼ Watt to 2 Watts, strobe output field selectable 15 to 110CD.
4. Smoke Detectors with Base: 5 units.
5. Heat Detectors with Base, Addressable: 5 units.
6. Heat Detector with Base, Fixed Temperature: 2 Units.
7. Duct Mounted Smoke Detector with Sampling Tubes and Remote Test Switch: 3 units.
8. Addressible Monitor Modules: 5 units.
9. Addressible Control Nodules: 5 units.
10. Keys and Tools: Five (5) extra sets for access to be locked and tamper proofed components.

1.07 WARRANTY

A. General Warranty: The special warranty 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. Special Warranty: A written warranty, signed by Contractor and manufacturer, agreeing to replace components that do not meet requirements or that fall within the specified warranty period.

1. Warranty Period: Two years from date of Final Acceptance. Full warranty applies throughout the warranty period.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide fire alarm and detection systems of one of the following:

1. Simplex Grinnell
2. Notifier
3. The equipment supplier shall provide the services of a factory trained representative. They shall supervise the system installation and final connections to the equipment and provide testing to assure that the system is in proper operating condition.
2.02 FIRE ALARM AND DETECTION SYSTEMS

A. General: Provide fire alarm and detection system products of types, sizes, and capacities indicated, which comply with manufacturer's standard design, materials, components; construct in accordance with published product information, and as required for complete installation. Provide fire alarm and detection systems for applications indicated, with the sequence of operations, components and function features indicated.

B. Materials and Equipment:

1. Wiring System Materials: Provide basic wiring materials which comply with 26 00 10 – Electrical General Provisions, 26 05 53 – Raceway and Boxes for Electrical Systems, and 26 05 19 - Low-Voltage Electrical Power Conductors and Cables; types to be selected by Installer.
   a. Junction and Pull Boxes:
      1) Junction and pull boxes shall be clearly marked. This shall be done by painting the covers red, and properly labeling them.
      2) All junction and pull boxes located at or above 8'0" from the floor shall be a minimum size of 4-11/16".
      3) No box extensions shall be permitted on new work.
      4) All junction boxes shall be readily accessible.
      5) No splicing in device mounting boxes.

C. Manufacturer's Equipment: Provide manufacturer's standard construction equipment for material noted below:

   a. Simplex 4100ES.
      1) All devices to be served from one (1) panel.
   b. Cabinet: Front lockable steel enclosure with a 14 gauge door and 16 gauge cabinet body, minimum. Arrange interior components so operations required for testing or for normal maintenance of the system are performed from the front of the enclosure. If more than one unit is required to form a complete control panel, fabricate with matching modular unit enclosure to accommodate components and to allow ample gutter space for field wiring and interconnecting panels.
      1) Identify each enclosure with an engraved, red, laminated, phenolic-resin nameplate with lettering not less than 1 inch high. Identify individual components and modules within cabinets with permanent labels.
      2) Mounting: Surface.
      3) Keys: Common to all system components.
   c. Password Protection: Multi-level, applicable to system functions such as alarm silence, alarm reset, manual control, and disable/enable. Access to a level allows the operator to perform all actions within that level plus all actions of lower levels.
   d. Communication Format: Digital poll/response protocol with each initiating and control device. The system shall verify that the type device at each address matches the software configuration.
   e. Event Storage:
      1) The system stores and logs alarm and trouble events. Each recorded event includes the time and date of the event's occurrence.
      2) The system has the capability of recalling alarms, detector verifications, trouble conditions, acknowledgments, and silencing and reset activities in chronological order for the purpose of recreating an event history.
      3) Memory: Battery protected random access memory.
      4) Alarm Log: 300 events. Trouble Log: 300 events.
      5) Available Reports:
a) Alarm, trouble and test conditions including the time and date of each occurrence.

b) Status of each device in the system including detector sensitivity and verification tally.

c) Detector trending.


1) Initiating Device Capacity: Refer to drawings for specific capacity requirements for future classroom wing addition. Provide adequate for quantity of devices indicated on drawings plus 10 percent.

2) Quantity of Simultaneous Alarms: Unlimited.

3) Maintenance Alert: Automatically warns of a contaminated detector prior to false alarm.

4) One additional signal line circuit (SLC) for future.

g. Control Modules: Include types and capacities required to perform all functions of fire alarm systems. Each circuit shall have 10 percent spare capacity.

h. Indications: Local, visible, and audible signals announce alarm, supervisory, and trouble conditions. Each type of audible alarm has a different sound.

i. Resetting Controls: Prevent the resetting of alarm, supervisory, or trouble signals while the alarm or trouble condition still exists.

j. Alphanumeric Display and System Controls: Arranged for interface between human operator at the Fire Alarm Control Panel and addressable system components, including annunciation, supervision, and control. Bypass switches shall provide specific alphanumeric display on the LCD annunciator.

1) Display: A minimum of 80 characters; alarm, supervisory, and component status messages; and indicate control commands to be entered into the system for control of smoke detector sensitivity and other parameters.

2) Keypad: Arranged to permit entry and execution of programming, display, and control commands.

3) Bypass Switches: Activation of a bypass switch allows system testing without operation of the bypassed circuit. A trouble condition is generated upon operation of a bypass switch. Provide bypass switches for the following:

   a) Remote monitoring station notification.
   b) Audio circuit.
   c) Visual circuit.
   d) Smoke dampers.
   e) Elevator recall.
   f) Fire doors.
   g) Door unlock (access control system interface)
   h) Sound reinforcement shut-down
   i) Theatrical lighting bypass

4) Control Switches: Switches allow manual control or testing of the following:

   a) Master AHU Shutdown
   b) Sound reinforcement shut-down
   c) Theatrical lighting bypass
   d) Alarm Test. Operation of switch simulates an alarm condition in the same manner as if a manual station was operated. Notification of the fire department or central monitoring station is bypassed.
k. Programming:
1) System Memory: Non-volatile, programmable.
2) Loading or editing of special instructions and operating sequences allowed as required.
3) Capable of on-site programming to accommodate and facilitate expansion, building parameter changes, or changes as required by local codes.
4) Provisions for disabling and enabling all addressable devices, and all monitoring, signaling and control circuits individually for maintenance and testing purposes.
5) Provisions for distinctly different evacuation tone for disaster warning purposes.
6) Smoke sensor sensitivity:
   a) Automatic sensitivity adjustment of each sensor based on time of day and day of week.
   b) Multiple sensitivity settings per sensor.
   c) Pre-alarm or two-stage function to provide an indication when a sensor reaches 50 percent of its alarm threshold.
7) Contractor shall provide a detailed device description label that includes Room Name, Building Area (1-5), Room Number, and Location in Building for common room name (i.e. Mech Room by main storage). Contractor shall verify names with Owner prior to any programming; if names are not verified the system shall be reprogrammed at no additional cost.

l. Control Switches:

<table>
<thead>
<tr>
<th>Access Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>City disconnect with digital readout</td>
</tr>
<tr>
<td>(for both alarms and troubles)</td>
</tr>
<tr>
<td>Audio bypass with digital readout</td>
</tr>
<tr>
<td>Visual circuit bypass with digital readout</td>
</tr>
<tr>
<td>Smoke damper bypass with digital readout</td>
</tr>
<tr>
<td>Fire door bypass</td>
</tr>
</tbody>
</table>

m. Provide air handler shutdown by specific unit or by fire zone (i.e. floor). Switch cannot be activated unless one or more of the following conditions occur:
1) Fire Alarm Control Panel is in access level 3.
2) Panel is in alarm condition.

n. Fire alarm control panel power shall be supplied by dedicated circuit(s).

a. Description: Fabricated of metal, and finished in red with molded, raised-letter operating instructions of contrasting color.
1) Double-action mechanism requires two actions, such as a push and a pull, to initiate an alarm.
2) Station Reset: Key or wrench operated; double pole, double throw; switch rated for the voltage and current at which it operates.
3) Integral Addressable Module: Arranged to communicate manual-station status (normal, alarm, or trouble) to the Fire Alarm Control Panel.
4) When surface-mounting pull stations, fire alarm equipment provider shall provide back boxes to match pull stations.

3. Smoke Detectors
a. General: Include the following features:
1) Operating Voltage: 24-V dc, nominal.
2) Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
3) Plug-in Arrangement: Detector and associated electronic components are mounted in a module that connects in a tamper-resistant manner to a fixed location.
base with a twist-locking plug connection. Terminals in the fixed base accept building wiring.

4) Sensitivity: Can be tested and adjusted in-place after installation.

5) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the Fire Alarm Control Panel.

6) Remote Controllability: Unless otherwise indicated, detectors are analog-addressable type, individually monitored at the Fire Alarm Control Panel for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the Fire Alarm Control Panel.

b. Photoelectric Smoke Detectors: Include the following features:
   1) Sensor: LED or infrared light source with matching silicon-cell receiver.
   2) Detector Sensitivity: Between 2.5 and 3.5 percent/foot smoke obscuration when tested according to UL 268A.
   3) Magnetically actuated test switch.
   4) Integral Thermal Detector: Fixed-temperature type with 135 deg F setting.

c. Duct Smoke Detector: Photoelectric type.
   1) Sampling Tube: Design and dimensions as recommended by the manufacturer for the specific duct size, air velocity, and installation conditions where applied.
   2) Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

4. Other Detectors
a. Heat Detector, Combination Type: Actuated by either a fixed temperature or rate of rise of temperature.
   1) Analog temperature measuring device with setpoint (rating) set by Fire Alarm Control Panel.
   2) Mounting: Plug-in base, interchangeable with smoke detector bases, where available.
   3) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the Fire Alarm Control Panel.

5. Notification Appliances
a. Description: Equip for mounting as indicated and have screw terminals for system connections.
   1) Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly.
   2) Provide factory UL Listed wire guards where indicated.

b. Visible Alarm Devices: Xenon strobe lights listed under UL 1971 with clear or nominal white polycarbonate lens. Mount lens on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- high letters on the lens.
   1) Rated Light Output: 15/75 candela minimum per UL 1971 for ADA use unless otherwise indicated on drawing or required to meet NFPA 72 criteria.
   2) Strobe Leads: Factory connected to screw terminals.
   3) Synchronized operation.
   4) Provide strobe for use in hazardous (classified) locations when indicated on the plans.
   5) Strobes shall be addressable.

c. Speakers:
   1) UL Listed to Standard 1480.
2) High Output Cluster Speakers: Rated 0.9 to 15 W.
   a) Combine multiple speakers into clusters as required for
      acoustical environment.
   b) White finish with ‘FIRE’ lettering.
   c) Cooper STH Series or equal.
3) Standard-Range Units: Rated 1/4 to 2 W.
4) Size:
   a) Ceiling-Mounted Speakers: 4 inch cone, off-white housing.
   b) Wall-Mounted speakers: 4 inch cone, white housing.
5) Mounting:
   a) Ceiling: Flush with white baffle.
   b) Wall: Surface with white housing over flush box.
   c) Include factory backbox for speakers which do not mount over a
      standard 4-inch junction box.
   d) Provide factory adapter skirts where speakers are surface mounted.
6) Matching Transformers: 25 or 70.7 VRMS and provide tap range matched to
   the acoustical environment of the speaker location.
7) Speakers shall be addressable.

6. Magnetic Door Holders
   a. Door holder furnished by door hardware sections, electrical connection by Electrical
      Contractor through the fire alarm panel. Door holders are to be connected at 24V,
      but are not required to be battery backed up.

7. Remote Annunciator
   a. Description: LCD (liquid crystal display) duplicate annunciator functions of the Fire
      Alarm Control Panel for alarm supervisory, and trouble indications. Duplicate manual
      switching functions of the Fire Alarm Control Panel including, acknowledging,
      silencing, reset, and test. Provide handheld microphone for manual audio input with
      selectable speaker circuits. Lockable steel enclosure keyed to match.
      1) Mounting: Semi-recessed cabinet.
   b. Display Type and Functional Performance: Alphanumeric display same as the Fire
      Alarm Control Panel. Controls with associated LEDs permit acknowledging,
      silencing, resetting, and testing functions for alarm, supervisory, and trouble signals
      identical to those in the Fire Alarm Control Panel.

8. Signal Circuit Remote Power Supply
   a. General: Filtered, regulated, power limited with trouble indication; with emergency
      power supply.
   b. Cabinet Lockable steel, surface-mounted enclosure, keyed to match, Fire Alarm
      Control Panel.

9. Battery Power Supply
   a. General: Components include valve-regulated, recombinant lead acid battery;
      charger; and an automatic transfer switch.
      1) Battery Nominal Life Expectancy: 4 years as a minimum.
   b. Battery Capacity: Comply with NFPA 72 for supplying a minimum of 24 hours of
      operation in normal condition, followed by no less than 15 minutes in full alarm for a
      system operating without a backup generator.
c. Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Provide capacity for 150 percent of the connected system load while maintaining batteries at full charge. If batteries are fully discharged, the charger recharges them completely within four hours. Charger output is supervised as part of system power supply supervision.

d. Integral Automatic Transfer Switch: Transfers the load to the battery without loss of signals or status indications when normal power fails.

10. Addressable Interface Devices

   a. Monitor Module: Microelectronic module listed for use in providing a multiplex system address for listed fire and sprinkler alarm-initiating devices with normally open contacts; allows individual monitoring of non-addressable points.

   b. Control Module: Microelectronic module listed for use in providing a multiplex system address to relays for system control functions.

      1) Relay: 24 VDC coil with red LED when in the "alarm" state; contacts rated 10A, 115 VAC, minimum; suitable for control function required.

11. Digital Alarm Communicator Transmitter

   a. Listed and labeled under UL 864 and NFPA 72.

   b. Functional Performance: Unit receives an alarm, supervisory, or trouble signal from the Fire Alarm Control Panel panel, and automatically captures one or two telephone lines and dials a preset number for a remote central station. When contact is made with the central station(s), the signal is transmitted. The unit supervises up to two telephone lines. Where supervising two lines, if service on either line is interrupted for longer than 45 seconds, the unit initiates a local trouble signal and transmits a signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. When telephone service is restored, unit automatically reports that event to the central station. If service is lost on both telephone lines, the local trouble signal is initiated.

PART 3 - EXECUTION

3.01 GENERAL

A. Audible device quantities and locations indicated on Fire Alarm drawings are based on the engineer's preliminary analysis utilizing commercially available speakers. Fire alarm designer shall select specific speaker models and tap settings as required for the application.

B. Fire alarm speaker quantities and locations indicated on Fire Alarm drawings shall not be reduced if fewer speakers in an ADS meet the performance requirements specified. Speaker locations indicated have been coordinated with other building components (lighting, HVAC, fire suppression, paging, etc.).

C. Where acoustically challenging areas require more speakers than indicated on the contract documents, it shall be brought to the attention of the engineer. Potential solutions shall be investigated.

D. Install the fire alarm system in accordance with approved manufacturer's wiring diagrams. Furnish all conduit, wiring, outlet boxes, junction boxes, cabinets, and similar devices necessary for a complete installation. Boxes shall be installed in accessible spaces without requiring the removal of light fixtures or any other equipment.

E. Coordinate system programming with the authority having jurisdiction.
F. Provide dedicated 120 volt power to remote notification appliance circuit (NAC) panels, remote amplifiers and all power supplies related to the fire alarm and emergency communications system.

G. Paint the fire alarm power supply disconnects red and label "Fire Alarm Circuit Control". All circuit breakers feeding dedicated fire alarm circuits shall be capable of being locked in the closed position.

H. Coordinate the installation of equipment and devices that pertain to the work of other trades with the appropriate contractors.

1. Provide connections to 120V smoke dampers provided by the mechanical contractor. Install 120V indicator lights provided with the dampers and wire to position switches.
   a. Provide dedicated 120 volt circuits for smoke dampers.

2. Provide shut-down relays to initiate HVAC shut down. Locations indicated on the fire alarm drawings are diagrammatic. Coordinate relay installation and HVAC unit shut-down with temperature controls contractor.

3. Provide interface relay to signal the Access Control System. Activation of the fire alarm system shall signal the Access Control System to unlock select doors. Coordinate installation with the Access Control System installer.

4. Provide interface relay to signal the Theatrical Lighting System. Activation of the fire alarm system shall signal the Theatrical Lighting System to bypass the dimmers and turn on all house lights. Coordinate interface with the Theatrical Lighting System installer.

5. Provide interface relay to signal the Sound Reinforcement Systems. Activation of the fire alarm system shall signal the Sound Reinforcement Systems to shut-down. Coordinate installation with the AV System installer.

4. Provide monitoring of kitchen hood chemical suppression systems. Activation of a chemical hood fire suppression system shall initiate general alarm.

5. Provide monitoring of fire suppression system.
   a. Activation of water flow shall initiate general alarm.
   b. Activation of valve tamper switches shall initiate a supervisory alarm.
   c. Provide monitoring of fire pump in accordance with NFPA 20.

   a. Provide primary and secondary recall signals.
   b. Monitor shunt-trip control power.
   c. Provide shunt-trip signal in accordance with ASME A17.1.

7. Temperature Controls Contractor will monitor all addressable points of the fire alarm system. Coordinate configuration and programming with the controls system contractor. Coordinate with Owner in advance of programming.

I. Provide switch and fuse stat's (type SOU) installed within the Fire Alarm Control Panel disconnect 120 VAC power and separately all battery power.

3.02 DEVICE INSTALLATION

A. Provide devices as indicated on drawings and as required to perform specified functions.

B. Initiating Devices:

1. Smoke Detectors:
   a. Cover all smoke detection devices immediately after installation to maintain cleanliness.
   b. Install within five feet of each door held open by the fire alarm system.
   c. Where adjacent to an air shaft, supply diffuser or return grille, install smoke detector 36 inches minimum from the edge of the diffuser or grille.
d. Provide a smoke detector within 10 feet of each remote power supply panel.

2. Duct Detectors:
   a. Provide a remote alarm LED indicator for each duct smoke detector which is not readily visible or which is located above a ceiling or on a roof. Mount in an easily accessible and readily visible location. Label with the name of the unit served by the detector. Indicate whether the detector is installed in the supply or return ductwork.
   b. Provide a labeled test switch with LED indicator for each duct smoke detector. Install switch at a height between 48 inches and 72 inches above finished floor.
   c. Where a duct mounted smoke detector is installed to control a smoke damper, detector is to be installed within 5'-0" or the smoke damper in accordance with the International Mechanical Code.

3. Program address for each device as directed by Owner or stated elsewhere in specification.
4. Program device output text by address and geographic location.
5. Provide an addressable interface module for each non-addressable device.
6. Provide an addressable interface module for each non-addressable initiating device.

C. Signaling Devices:
1. Where plans indicate a signaling device installed adjacent to a manual station, install the signaling device on the wall directly above the manual station.
2. Provide a minimum of two weatherproof audible signaling devices of the same type as other signaling devices provided with the system. The audible signaling devices will be located by the fire department connection to each building. Owner will determine the exact locations. Mount the devices on the exterior of the building. Provide a separate circuit for exterior audible signaling devices.
3. In sprinkled buildings, provide a 120 volt circuit to the fire sprinkler bell location. Provide manual bypass from the Fire Alarm Control Panel.
4. Signaling devices shall be completely deactivated by pressing "signal silence".
5. Specific audible devices and tap settings shall be selected by the fire alarm designer to comply with the audibility and intelligibility requirements of NFPA 72. The Sound Pressure Level (SPL) shall exceed ambient sound levels by 15dbA for the tone portion of the signal. Intelligibility of the emergency communication system shall be considered acceptable if at least 90 percent of the measurement locations within each ADS have a calculated STI of not less than 0.45 (0.65 CIS) and an average STI of not less than 0.5 STI (0.70 CIS)

D. Control Devices:
1. All devices controlled by the Fire Alarm Control Panel (i.e. dampers, doors, elevators, etc.) shall be operated by the use of "control modules" and not by relay type device on detector bases. No auxiliary equipment shall be directly connected to LMX control modules. Control modules shall activate a 24VDC relay with LED when in the "alarm".
2. Elevators: Verify recall requirements with local codes, authorities, and installers prior to system programming. Provide control modules and relays as required.
3. Provide a control module and relay for each door or group of doors to be held open.
4. Provide control modules and relays as required to implement the required control sequences.
5. Provide control modules and relays for remote indication of alarm and trouble conditions.

E. Door Holders:
1. Electromagnetic door holders shall be furnished by the Architect. Provide wiring so the door holders are normally energized from the fire alarm power supply.
2. Mount at the top of each door to be held open unless otherwise indicated.
3. Mount the magnet on the wall and the contact plate on the door. Provide extensions as necessary to assure proper mating between the magnet and contact plate. Magnet is to maintain hold of door under normal conditions.
4. Adjust so the door is held parallel to the wall on which the magnet is mounted.
F. Cabinets:
   1. Mount Fire Alarm Control Panel and remote cabinets a maximum of 72 inches above finished floor to the top of the cabinet. Provide a 4-inch space between adjacent cabinets.

3.03 WIRING INSTALLATION

A. Wiring Method: Install wiring in metal raceway according to Division 26, Section 26 0533 - Raceways and Boxes for Electrical Systems. Conceal raceway except in unfinished spaces and as indicated.

B. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by the manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors. Do not install spare conductors in conduits or junction boxes.

C. Cable Taps: All cables in the fire alarm control panel, junction boxes, and pull boxes shall be clearly marked in English (i.e. SLC 1, 3rd Floor Speakers, etc.). Label all junction box covers to indicate circuits and/or devices enclosed. Label inside cover of all junction boxes in finished areas. Label outside cover of all junction boxes in unfinished/concealed areas.

D. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red and provide circuit labels on inside of cover.

E. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the Fire Alarm Control Panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

F. Install end-of-line resistors at the farthest device from panel or module in a separate junction box clearly marked "End-of-Line Resistor.

G. Conductors (minimum size and color) and raceways shall be provided as listed below, unless otherwise recommended by the system manufacturer or required by the authority having jurisdiction:

   1. 120VAC 12AWG
   2. Initiating circuits #18 tw/sh pair White (+) Black (-)
   3. Audible signaling circuits
      a. Horns/bells #14AWG Red (+) Black (-)
   4. Module power #14AWG Violet (+) Blue (-)
   5. Resettable module power #14AWG Yellow (+) Gray(-)
   6. Visual signaling circuits #14AWG Red (+) Black (-)
   7. Door holder/smoke dampers #14AWG Brown (+) White (-)
   8. Control circuits #14 AWG

H. Conduit fill and box fill never to exceed 50%.

I. No spare conductors shall be installed in conduits or junction boxes.

J. 3M #130C rubber tape (or approved equal) shall be used to insulate grounding shields.

K. All junction and pull boxes located at or above 8'-0" from the floor shall be a minimum size of 4-11/16"
square by 2-1/8" deep.

L. No box extensions shall be permitted on new work.

M. All fire alarm devices, junction and pull boxes shall be installed so they are accessible without removing light fixtures, equipment, conduits, junction boxes or other items.

N. No splicing will be allowed in device mounting boxes.

O. "End of Line Resistors" shall be located at the device that is farthest away from the panel or module.

P. All devices being controlled by the fire alarm control panel (i.e. dampers, doors, etc.) shall be operated by the use of control modules and not by relay type devices in detector bases. No auxiliary equipment shall be directly connected to an addressable control module. Each control module shall activate a 24 vdc relay with LED when in the "alarm" state.

Q. Back boxes shall be provided by equipment supplier for any surface-mounted pull stations or signaling devices.

R. T-taps may be used for signaling line circuits if manufacturer's recommendations are followed.

3.04 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals according to Division 26, Section Identification for Electrical Systems.

B. Install instructions frame in a location visible from the Fire Alarm Control Panel.

C. Paint power-supply disconnect switch or breaker red and label "FIRE ALARM".

D. Affix the name and telephone number of the local service organization to the inside of the door of the Fire Alarm Control Panel and each remote cabinet.

E. Label each control module to indicate the equipment controlled.

F. Maintain wiring color codes throughout the system.

G. All labels shall be on the inside of the cover.

3.05 GROUNDING

A. Ground cable shields and equipment according to system manufacturer's written instructions to eliminate shock hazard and to minimize, to the greatest extent possible, ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
B. Ground equipment and conductor and cable shields. For audio circuits, minimize, to the greatest extent possible, ground loops, common-mode returns, noise pickup, cross talk, and other impairments. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.

3.06 ACCEPTANCE TESTING

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and connections and to supervise pretesting, testing, and adjustment of the system. Report results in writing.

B. Electrical Contractor shall be responsible for performing a “Pre-Test” of the Fire Alarm System and preparing/ completing “Test Log”.

1. All equipment shall be installed prior to completing "Pre-Test".
2. Scope of the Pre-Test is to:
   a. "Align, adjust, and balance the system.”
   b. Confirm compliance with the drawings and specifications.
   c. Install, test and check for operation of 100% of all fire alarm equipment and items being controlled by the fire alarm system.
3. Manufacturer’s representative is to be involved in the pre-test.
4. Perform a thorough cleaning of the fire alarm system so each detector’s chamber value reads less than 50%.
5. At completion of the pre-test, the fire alarm system is to be complete and ready for owner acceptance.
6. Complete a “Test Log”, a written record of inspections, tests, and detailed test results.

C. In preparation for the final test, Contractor shall:

1. Submit a “Test Log” and test forms from NFPA 72 and include a print out proving detector chamber values of less than 50% for all detectors.
2. Provide a letter certifying pre-test compliance and a list of witnesses.
3. Record drawings shall be provided and a University of Iowa certification form shall be completed at the time of scheduling of the final inspection.
4. Provide an up to date and complete printout of software at the time of final inspection and after any and all corrections or changes.
5. Upon approval of the above items, schedule the Final Test with Owner’s representative with a minimum of 10 days notice. Those present shall be Manufacturer’s representative, Owner’s representative, Contractor and necessary local code and fire authorities.

D. Contractor shall perform a Final “Minimum System Test” per NFPA 72.

1. Contractor shall test all equipment per minimum system testing requirements and maintain a "Test Log".
2. Contractor to have sufficient personnel to conduct the test efficiently.
3. Upon completion of the Final Test Contractor will submit the Test Log.
4. Owner’s representative has the authority to void the Final Test if it is proven during the Final Test that the Fire Alarm system installation is not complete.
   a. Voiding the Final Test will require Contractor to schedule another Final Test.
5. Upon approval of Final Test, successful owner training and submittal of completed “As-Built” drawings and O&M manuals, Owner will provide Contractor with acceptance of new Fire Alarm System.
   a. Owner acceptance does not constitute “Project Closeout” or completion of “Final Punch List”
   b. Owner acceptance only relieves Contractor of testing requirements, it does not
relieve Contractor of other contract requirements.

c. Final Testing does not constitute Owner training.
d. Owner acceptance provides approval to activate the new Fire Alarm System as the primary system.

6. Contractor shall perform final test in the presence of manufacturer's representative, Owner's representatives, and necessary local code authorities.

E. Minimum System Tests' test the system according to procedures outlined in NFPA 72. Minimum required tests are as follows:

1. Verify the absence of unwanted voltages between circuit conductors and ground.
2. Test all conductors for short circuits using an insulation-testing device.
3. With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohm meter. Record the circuit resistance of each circuit on record drawings.
4. Verify that the control unit is in the normal condition as detailed in the manufacturer's operation and maintenance manual.
5. Test initiating and indicating circuits for proper signal transmission under open circuit conditions. One connection each should be opened at not less than 10 percent of initiating and indicating devices. Observe proper signal transmission according to class of wiring used.
6. Test each initiating and indicating device for alarm operation and proper response at the control unit. Test smoke detectors with actual products of combustion.
7. Test the system for all specified functions according to the approved operation and maintenance manual. Systematically initiate specified functional performance items at each station, including making all possible alarm and monitoring initiations and using all communications options. For each item, observe related performance at all devices required to be affected by the item under all system sequences. Observe indicating lights, displays, signal tones, and annunciator indications. Observe all voice audio for routing, clarity, quality, freedom from noise and distortion, and proper volume level.
8. Test Both Primary and Secondary Power: Verify by test that the secondary power system is capable of operating the system for the period and in the manner specified.
9. Perform test of emergency communications system as specified below.
10. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets Specifications and complies with applicable standards.

F. The manufacturer's authorized representative shall perform a 100% quality inspection of the final installation and in the presence of Contractor, Owner's Representative and local code and fire authorities, shall perform a complete finished test of all aspects of the system. A system certification verifying the proper system operation shall be required prior to acceptance.

G. Fire alarm testing shall include measurements of the emergency communications system for each Acoustically Distinguishable Space (ADS). Measurements of each ADS shall include Speech Transmission Index (STI) and Sound Pressure Level (SPL). Speech intelligibility measurements may also be expressed in Common Intelligibility Scale (CIS).

1. Intelligibility of the emergency communication system shall be considered acceptable if at least 90 percent of the measurement locations within each ADS have a calculated STI of not less than 0.45 (0.65 CIS) and an average STI of not less than 0.5 STI (0.70 CIS).
2. Audibility of the emergency communication system shall be considered acceptable if the average of the measurement locations within each ADS have a SPL of not less than 15dB above ambient levels during the initial signal tone generation.

3.07 CLEANING AND ADJUSTING

A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marred finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer. Provide detector cleaning report proving a maximum chamber value of 50% for all detectors.

3.08 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, adjusting, and maintaining equipment and schedules. Provide a minimum of 8 hours training.
2. Provide a minimum of 8 hours of software program training.
3. Training Aid: Use the approved final version of the operation and maintenance manual as a training aid.
4. Schedule training with Owner, through Engineer, with at least seven days advance notice.

3.09 MAINTENANCE

A. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels, controls, and sensitivities to suit actual occupied conditions. Provide up to three requested visits to Project site for this purpose.

B. Provide a maintenance contract from the local service organization beginning on the date of Substantial Completion and remaining in force throughout the warranty period. Include required NFPA testing at times scheduled by Owner.

C. Provide Owner with a proposal from the local service organization for a one-year maintenance contract beginning at the end of the warranty period.

END OF SECTION 28 31 00
SECTION 28 50 00 - ACCESS CONTROL SYSTEM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 28 00 10 – Electronic Safety and Security General Provisions are applicable to work required of this section.

B. Project is a multi-year phased project. Refer to plans for phasing notes as they relate to delivery of equipment. Contractor must account for appropriate price increases and or secure storage of materials and equipment to comply with phasing requirements.

1.02 DESCRIPTION OF WORK

A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this access control in compliance with the specifications and drawings. Contractor will provide and install all of the required material to form a complete system whether specifically addressed in the technical specifications or not.

1.03 SUBMITTALS

A. Submittal data for access control cabling and components shall consist of catalog cuts showing technical data necessary to evaluate the materials.

1.04 WORK BY OTHERS

A. Unless noted otherwise, the building’s Electrical Contractor will provide field device backboxes as needed, and conduit paths for use by Access Control Contractor. In general, the following is provided:

1. Available space on Telecom Room plywood wall to surface mount head end equipment as required with telecommunications room ground bus bar available for grounding.

1.05 FIRESTOPPING

A. Contractor shall be responsible for firestopping all conduit sleeves and cable tray where required to maintain integrity of fire and/or smoke walls. Contractor shall see architectural drawings for walls that require fire rating.

1.06 ACCEPTABLE ACCESS CONTROL CONTRACTORS

A. The following contractor shall be selected to build upon existing campus wide systems already in place:

1. Johnson Controls

PART 2 - PRODUCTS

2.01 ACCESS CONTROL CABLING AND COMPONENTS

A. Acceptable Manufacturers:

1. Johnson Controls Pegasus Access Control
B. Additional Requirements:

1. Access control cabling shall be home-run to the main system hardware, no splicing.
2. Any door identified on the plans that has any of the system components {door contacts (sometimes called position switches) of all types, card readers, request to exit devices, electrified door hardware of all types} shall be considered an access control system door.
3. Any door that is considered an access control system door shall have door contacts that can ensure the door is in the closed position and that the door is latched unless specifically noted otherwise. This is accomplished with two individual contacts, one for the door slab and one for the door hardware latch position. Each of these contacts shall have a dedicated alarm point in the system.
   If an electric strike is being provided with a latch bolt monitoring contact internal to the strike, a door slab contact shall still be provided to monitor the position of the slab. It shall be the Access Control Contractor’s responsibility to:
   1) verify that a suitable (workable for his or her needs) latch bolt monitoring contact is being specified in the door hardware, or point out that what is specified is not compatible with the access control product being provided or the system requirements placed upon the Contractor.
   2) provide and install a door slab contact which, when these two are used together, accomplish the requirements of knowing that the door slab is physically closed and the door hardware is engaged therefore ensuring a secured doorway (see other item about each contact needing to alarm independently).
4. The Access Control Contractor shall provide and install all cabling necessary for a complete and operational system taking into account all access control system devices called out on the plans (door contacts of all types, card readers, request to exit devices either internal to door hardware or surface mounted, and electrified door hardware of all types).
5. The Access Control Contractor shall provide and install all devices not specifically identified on the plans which are required for a complete and operational system for all access control system doors.
6. The Access Control Contractor shall provide and install one client software package on an Owner provided computer.
7. The Access Control Contractor shall furnish 100 proximity cards.
8. ADA door operation: Doors that are part of the access control system and also have ADA electric openers shall be subject to the following hardware/software requirements. The Access Control Contractor shall provide and install the necessary physical equipment and/or programming or other soft services necessary to meet these requirements.
   The card reader shall be located in close proximity to the ADA button (whether on the building wall or on a bollard or equivalent).
   During times when the system is scheduled to have the door of interest unlocked, pressing the ADA button (no card presentation required) shall physically open the door (and retract the latch as necessary). The access control system shall only unlock door trims during the unlocked door schedule (the latch shall remain engaged so the door cannot be opened by the wind or by people without using the door hardware). The Access Control Contractor shall coordinate with door hardware provided.
   During times when the system is scheduled to have the door of interest locked, pressing the ADA button after a valid card presentation shall activate any electric door hardware or electric opening devices (which might damage or destroy that equipment when trying to open against a locked door). The valid card presentation shall only allow activation of these electrical systems for a limited amount of time after the card presentation.
At no time shall a valid card presentation automatically activate the electric door opening device. Pressing the ADA button to have the door electrically open shall always be required, subject to the requirements listed above.

9. The Access Control head end (all cabinets if multiple) shall be furnished and installed with a minimum 7ah of battery backup serving no more than 8 doors each (i.e. if one panel serves 16 doors, then two 7ah batteries are required minimum). A battery backed power supply of the same manufacturer as the access control system shall be used if available, otherwise Altronix is an acceptable manufacturer to use.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install systems cables and auxiliary materials as indicated in accordance with access control manufacturer’s written instructions, and recognized industry practices.

1. Contractor shall use hook and loop type fasteners on all security cable. Tie wraps shall not be used.

B. Identify all cables as to field location.

1. Provide manufacturer’s standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type; either pre-numbered plastic coated type, or write-on type with clear plastic self-adhesive cover flap; numbered to show cable identification. Install within 6” of cable end.

C. After completion, all cables shall be thoroughly tested.

1. Contractor shall provide all instruments for testing the cables.
2. Contractor shall demonstrate in the presence of Owner’s representative that the access control is complete and operational.
3. Contractor shall complete and submit the Certificate of System Demonstration.

D. After completion, comprehensive As-Builts will be created and provided to Owner within 14 days.

1. Two hard copies shall be provided to Owner detailing the entire access control after installation. Each field position shall be labeled and cross referenced to the appropriate head end position for ease of troubleshooting.

3.02 COMMISSIONING

A. The Contractor shall coordinate a date/time with the Engineer after the system is fully operational, but before final payment, for the Contractor to provide a full system demonstration. This shall include all aspects of system operation that the user might encounter.

END OF SECTION 28 50 00
PART 1 - GENERAL

1.01 RELATED DOCUMENTS
A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 28 00 10 – Electronic Safety and Security General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK
A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this surveillance system in compliance with the specifications and drawings. Contractor will provide and install all of the required material to form a complete system whether specifically addressed in the technical specifications or not.

1.03 SUBMITTALS
A. Submittals for all Manufacturer and Contractor certifications (noted below) shall be submitted first.
B. Submittal data for surveillance cabling and components shall consist of catalog cuts showing technical data necessary to evaluate the materials.

1.04 WORK BY OTHERS
A. Unless noted otherwise, the building’s Electrical Contractor will provide field device backboxes as needed, and conduit paths for use by surveillance Video Surveillance Contractor. In general, the following is provided:
   1. Grounded rack in 1706E Server Room to mount head end equipment to.

1.05 FIRESTOPPING
A. Contractor shall be responsible for firestopping all conduit sleeves and cable tray where required to maintain integrity of fire and/or smoke walls. Contractor shall see architectural drawings for walls that require fire rating.

1.06 ACCEPTABLE VIDEO SURVEILLANCE CONTRACTORS
A. The following contractors are pre-approved to bid this job:
   1. Video Surveillance Contractor shall be a Milestone Systems certified dealer in good standing for a minimum of six continuous months before the project bid date. This shall include factory trained and certified technicians in house for the installation of this project (six months’ experience applies here also). The dated dealer certification document and the dated technician training certificate are each required submittal items. For this project Milestone Corporate training is mandatory since this software is significantly different to implement from the next lower level. This Milestone Corporate training certificate is required in the submittals to show an acceptable contractor is on the project.
   2. Video Surveillance Contractor shall be an Axis Silver (or better) certified camera dealer in good standing for a minimum of six continuous months before the project bid date. This shall include factory trained and certified technicians in house for the installation of this project (six months experience applies here also). The dated Axis Silver certified camera dealer document and the dated technician training certificate are each required submittal items.
3. The four or more submittal items (if multiple technicians) noted above are all criteria which determine if the Contractor is authorized to enter the team and begin work. No project work shall be authorized until these submittals are reviewed with a favorable response. Product data submittals are a separate submittal package and shall only be reviewed after the above items are resolved.

4. Contractor shall be located within 125 miles of the construction site to establish a potential two hour response time for ongoing customer needs after construction completion.

PART 2 - PRODUCTS

2.01 VIDEO SURVEILLANCE CABLELING AND COMPONENTS

A. Acceptable Manufacturers:
   1. Video Management Software: Milestone XProtect Corporate.
   2. Cameras: Axis Communications
   3. Video Management Server: Seneca

B. Additional Video Surveillance Requirements:
   1. All power and video cables shall be home-run, no splicing.
   2. Contractor shall coordinate with the Owner regarding setting up access to the system for individuals and also to what portion of the district they have access to.
   3. The Contractor shall furnish three (3) year Milestone camera licenses for all cameras provided in the project, and program all the associated DLK (device license key) into the software to make the cameras operational.
   4. Three (3) year Milestone software upgrade program shall be provided with each camera in the project.
   5. The Contractor shall aim all cameras per Owner direction.
   6. The Contractor shall program all camera names into the system per Owner direction.
   7. The Contractor shall furnish and install Seneca video surveillance system server 300i-32T-4L-WS12; coordinate specific Microsoft Server version with College Community School district IT support.
   8. The Contractor shall furnish and install in the rack supporting the servers: (1) 1U Rackmount 19" LCD screen/keyboard with touchpad console unit. The console shall support digital video input with a minimum resolution of 1920 x1080. Include (1) multi-port KVM/USB switch with a minimum of 4 USB ports. The switch shall support digital video switching of 1080p.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install surveillance systems cables and auxiliary materials as indicated in accordance with manufacturer’s written instructions, and recognized industry practices.
   1. Contractor shall use hook and loop type fasteners on all security cable. Tie wraps shall not be used.

B. Identify all cables as to field location.
   1. Provide manufacturer’s standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type; either pre-numbered plastic coated type, with clear plastic self-adhesive cover flap; numbered to show cable identification. Install within 6” of cable end.
C. After completion, all cables shall be thoroughly tested.
   1. Contractor shall provide all instruments for testing the cables.
   2. Contractor shall demonstrate in the presence of Owner’s representative that the surveillance system is complete and operational.
   3. Contractor shall complete and submit the Certificate of System Demonstration.

D. After completion, comprehensive As-Builts will be created and provided to Owner within 14 days.
   1. Two hard copies shall be provided to Owner detailing the entire security system after installation. Each field position shall be labeled and cross referenced to the appropriate head end position for ease of troubleshooting.

3.02 COMMISSIONING

A. The Contractor shall coordinate a date/time with the Engineer after the system is fully operational, but before final payment, for the Contractor to provide a full system demonstration. This shall include all aspects of system operation that the user might encounter.

END OF SECTION 28 60 00
SECTION 31 10 00 - SITE CLEARING

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.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Stripping and stockpiling rock.
6. Removing above- and below-grade site improvements.
7. Disconnecting, capping or sealing, and removing site utilities or abandoning site utilities in place.
8. Temporary erosion and sedimentation control.

1.3 DEFINITIONS

A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow.

D. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects larger than 2 inches in diameter; and free of weeds, roots, toxic materials, or other nonsoil materials.

E. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and indicated on Drawings.

F. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and indicated on Drawings.

G. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.
1.4 MATERIAL OWNERSHIP

A. Except for 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. Note: All topsoil, stockpiled or otherwise are Owners property and shall remain onsite.

1.5 INFORMATIONAL SUBMITTALS

A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.

1. Use sufficiently detailed photographs or video recordings.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plant designated to remain.

B. Topsoil stripping and stockpiling program.

C. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 QUALITY ASSURANCE

A. Topsoil Stripping and Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.

1.7 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, 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 trafficways if required by Owner or authorities having jurisdiction.

B. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

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. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.
PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Fill."
   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. Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged and that protection zones have been identified and enclosed.

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. Protect trees and plants remaining on-site.

B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations.
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.
   2. Owner will arrange to shut off indicated utilities when requested by Contractor.

B. Locate, identify, and disconnect utilities indicated to be abandoned in place.

C. 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.

D. Excavate for and remove underground utilities indicated to be removed.

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
   1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
   2. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches below exposed subgrade.
   3. Use only hand methods or air spade for grubbing within protection zones.
   4. Chip removed tree branches and dispose of off-site.

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 to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.
   1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects larger than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. 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.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.

2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

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
SECTION 31 20 00 – EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Preparing subgrades for slabs-on-grade, walks and pavements.
   2. Excavating and backfilling for buildings and structures.
   3. Drainage course for concrete slabs-on-grade.
   4. Subbase course for concrete pavements.
   5. Excavating and backfilling for utility trenches.

1.2 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. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

C. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

D. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

E. 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.

F. Fill: Soil materials used to raise existing grades.

G. 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.

H. 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.
I. 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.

J. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.3 QUALITY ASSURANCE

A. Pre-excavation Conference: Conduct conference at pre-construction meeting set forth in the contract documents.

1.4 PROJECT CONDITIONS

A. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth moving operations.

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 Group CL according to ASTM D 2487, or as approved by geotechnical testing services or in 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 Max.
2. Plasticity Index: 23 Max

C. Unsatisfactory Soils: Soil Classification Groups OL, MH, 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:

1. Modified Subbase: Iowa DOT Gradation 14, Specification Section 4123, as noted on plans.

E. 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.

F. Bedding Course: Class 1 Bedding Material: Iowa DOT Standard Specification Section 4115, Gradation Number 3.

G. Drainage Course: Iowa DOT Standard Specification Section 4131 Gradation Number 29, as indicated on drawings.
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 015639 "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: As indicated in details.

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 015639 "Temporary Tree and Plant Protection."

3.6 SUBGRADE INSPECTION

A. Proof-roll subgrade 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. See Specification Section 312323 for Backfilling

D. Place and compact final backfill to final subgrade elevation. See Specification Section 312323 for Backfilling

E. 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. See Specification Section 312323.

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 COMPACTION OF SOIL BACKFILLS AND FILLS

A. See Specification Section 312323.
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 on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course under pavements and walks as follows:

1. Shape subbase course to required crown elevations and cross-slope grades.
2. Place subbase 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 at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 98 percent of maximum dry unit weight according to ASTM D 698.

3.15 **DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE – Not used**

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, unless otherwise noted on drawings.

END OF SECTION
SECTION 31 22 00 – GRADING

PART 1 – GENERAL

1.01 SECTION INCLUDES
A. Rough grading the site for site structures and building pads.
B. Replacement of topsoil and finish grading for planting.

1.02 RELATED REQUIREMENTS
A. Section 31 10 00 - Site Clearing.
B. Section 31 22 00 – Earth Moving.
C. Section 31 23 23 - Fill: Filling and compaction.
D. Section 32 92 23 - Sodding: Finish ground cover.
E. Section 32 93 00 - Plants: Topsoil in beds and pits.

1.03 PROJECT CONDITIONS
A. Protect above- and below-grade utilities that remain.
B. Protect plants, lawns, and other features to remain as a portion of final landscaping.
C. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs from grading equipment and vehicular traffic.

PART 2 PRODUCTS

2.01 MATERIALS
A. Topsoil: Topsoil excavated on-site.
   1. Free of roots, rocks larger than 1/2 inch, subsoil, debris, large weeds and foreign matter.
B. Other Fill Materials: See Section 31 23 23.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that survey bench mark and intended elevations for the Work are as indicated.

3.02 PREPARATION
A. Identify required lines, levels, contours, and datum.
B. Stake and flag locations of known utilities.
C. Locate, identify, and protect from damage above- and below-grade utilities to remain.

3.03 ROUGH GRADING
A. Remove subsoil from areas to be further excavated, re-landscaped, or re-graded.
B. Do not remove wet subsoil, unless it is subsequently processed to obtain optimum moisture content.
C. When excavating through roots, perform work by hand and cut roots with sharp axe.
D. See Section 31 23 23 for filling procedures.
E. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill.

3.04 SOIL REMOVAL and STOCKPILING
A. Stockpile excavated topsoil on site.
B. Stockpile subsoil to be re-used on site; remainder topsoil shall remain on site.
C. Stockpiles: Use areas designated on site; pile depth not to exceed 8 feet; protect from erosion.

3.05 FINISH GRADING
A. Before Finish Grading:
   1. Verify building and trench backfilling have been inspected.
   2. Verify subgrade has been contoured and compacted.
B. Remove debris, roots, branches, stones, in excess of 1/2 inch in size. Remove soil contaminated with petroleum products.
C. Where topsoil is to be placed, scarify surface to depth of 6 inches.
D. In areas where vehicles or equipment have compacted soil, scarify surface to depth of 6 inches.
E. Place topsoil in areas where seeding, sodding, and planting are indicated.
F. Place topsoil where required to level finish grade.
G. Except as specifically indicated otherwise, place topsoil to the following compacted thicknesses:
   1. Areas to be Seeded with Grass: 6 inches minimum.
   2. Areas to be Sodded: 6 inches minimum.
   3. Shrub Beds: 12 inches minimum. See Landscape Plan for details and compost requirements.
H. Place topsoil during dry weather.
I. Remove roots, weeds, rocks, and foreign material while spreading.
J. Near plants spread topsoil manually to prevent damage.
K. Fine grade topsoil to eliminate uneven areas and low spots. Maintain profiles and contour of subgrade.
L. Lightly compact placed topsoil.

3.06 TOLERANCES
A. Top Surface of Subgrade: Plus or minus 1/10 foot from required elevation.
B. Top Surface of Finish Grade: Plus or minus 1/2 inch.

3.07 CLEANING
A. Remove unused stockpiled topsoil and subsoil. Grade stockpile area to prevent standing water.
B. Leave site clean and raked, ready to receive landscaping.

END OF SECTION
SECTION 31 23 23 – FILL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Filling, backfilling, and compacting for footings, slabs-on-grade, paving, site structures, and utilities within the building.
B. Backfilling and compacting for utilities outside the building to utility main connections.

1.02 RELATED REQUIREMENTS

A. Section 31 22 00 – Grading: Removal and handling of soil to be re-used.
B. Section 31 20 00 – Earth Moving: Removal and handling of soil to be re-used.
C. Section 33 46 00 - Subdrainage: Filter aggregate and filter fabric for foundation drainage systems.
D. Section 01 57 13 - Temporary Erosion and Sedimentation Control: Slope protection and erosion control.

1.03 PRICE & PAYMENT PROCEDURES

A. See Section 01 20 00.

1.04 REFERENCE STANDARDS

A. ASTM D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)); 2007.
B. ASTM D 2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2006.
C. ASTM D2922 Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth); 2006.

1.05 DEFINITIONS

A. Finish Grade Elevations: Indicated on drawings.
B. Subgrade Elevations: Indicated on drawings.

1.06 SUBMITTALS

A. See Section 01 33 00 - Construction Submittals, for submittal procedures.
B. Materials Sources: Submit name of imported materials source.
C. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used.
D. Compaction Density Test Reports.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide sufficient quantities of fill to meet project schedule and requirements. No area is available to store materials on site in advance of need.

B. When fill materials need to be stored on site, locate stockpiles where indicated.
   1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
   2. Prevent contamination.
   3. Protect stockpiles from erosion and deterioration of materials.

C. Verify that survey bench marks and intended elevations for the Work are as indicated.

PART 2 PRODUCTS

2.01 FILL MATERIALS

A. General Fill: Subsoil excavated on-site and conforming to the following:
   1. Low-plasticity, cohesive type.
      a. Liquid Limit: Less than 45 percent.
      b. Plasticity Index: Less than 25 percent.
   2. Free of lumps larger than 3 inches, rocks larger than 2 inches, and debris.
   3. Conforming to ASTM D 2487 Group Symbol CL.

B. Modified Subbase Fill: Dense angular crushed stone; IDOT Standard Specification Section 4123, gradation number 14 as indicated on drawings.

C. Granular Drainage Fill: Angular crushed washed stone; open-graded, processed aggregate; free of shale, clay, friable material and debris; and conforming to the following:
   1. IOWA DOT Gradation 29, Section 4131.

D. Sand: Natural river or bank sand; washed; free of silt, clay, loam, friable or soluble materials, and organic matter.
   1. Grade in accordance with ASTM D 2487 Group Symbol SW.

D. Aggregate Bedding shall meet the following gradation: Class 1 Material (SUDAS)

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<th>½</th>
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F. Topsoil: See Section 31 22 00.

2.02 ACCESSORIES

A. Geotextile Filter Fabric: See Section 33 46 00.
2.03 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for general requirements for testing and analysis of soil material.

B. Where fill materials are specified by reference to a specific standard, test and analyze samples for compliance before delivery to site.

C. If tests indicate materials do not meet specified requirements, change material and retest.

E. Provide materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.01 EXAMINATION

A. Identify required lines, levels, contours, and datum locations.

B. See Section 31 22 00 for additional requirements.

C. See Section 00 31 00 for Geotechnical Report recommendations.

D. Verify subdrainage, dampproofing, or waterproofing installation has been inspected.

E. Verify structural ability of unsupported walls to support imposed loads by the fill.

3.02 PREPARATION

A. Scarify and proof roll subgrade surface to a depth of 8 inches, moisture condition and compact to the minimum specified percent compaction.

B. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.

C. Compact subgrade to density equal to or greater than requirements for subsequent fill material.

D. Until ready to fill, maintain excavations and prevent loose soil from falling into excavation.

3.03 FILLING

A. Fill up to subgrade elevations unless otherwise indicated.

B. Employ a placement method that does not disturb or damage other work.

C. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.

D. Maintain optimum moisture content of fill materials to attain required compaction density.

E. Granular / Aggregate Fill: Place and compact materials in equal continuous layers not exceeding 6 inches compacted depth.

F. Soil Fill: Place and compact material in equal continuous layers not exceeding 8 inches compacted depth.

G. Slope grade away from building minimum 2 inches in 10 ft, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.

H. Correct areas that are over-excavated.

2. Other areas: Use general fill, flush to required elevation, compacted to minimum 98 percent of maximum dry density.

I. Compaction Density Unless Otherwise Specified or Indicated:

1. Under paving, slabs-on-grade, and similar construction: 95 percent of maximum dry density unless within one foot of final subgrade elevation, then 98 percent of maximum dry density.

2. Under lawn areas: 90 percent of maximum dry density.

J. Reshape and re-compact fills subjected to vehicular traffic.

3.04 FILL AT SPECIFIC LOCATIONS

A. Use general fill unless otherwise specified or indicated.

B. Subgrade Under Interior Slabs-On-Grade:

1. Scarify and recompact top 12 inches of existing subsoil to 98 percent of its maximum dry density before placing additional fill.

2. Use general fill at optimum moisture as replacement for unsatisfactory subsoil materials.

3. Fill up to subgrade elevations below capillary barrier.

4. Compact to 98 percent of maximum dry density.

C. Over Buried Utility Piping, Conduits, and Duct Bank in Trenches:


2. Cover with general fill except storm sewer under pavement shall be backfilled with granular drainage fill to bottom of subgrade elevation.

3. Fill up to subgrade elevation.

4. Compact in maximum 8 inch lifts to 98 percent of maximum dry density under paved areas and to 90% off maximum dry density under lawn areas.

D. At Lawn Areas:

1. Use general fill.

2. Fill up to 6 inches below finish grade elevations.

3. Compact to 90 percent of maximum dry density.

4. See Section 31 22 00 for topsoil placement.

E. Under Monolithic Paving:

1. Scarify and recompact top 12 inches of existing subsoil to 98 percent of its maximum dry density before placing additional fill.

2. Use additional general fill as required to achieve final subgrade elevation.

   a. Maximum compacted depth of each lift: 8 inches.
b. Compact to 95 percent of maximum dry density unless within one foot of final subgrade elevation, then 98 percent of maximum dry density.

3. See Section 32 11 23 for aggregate base course placed over fill.

3.05 **TOLERANCES**

A. Top Surface of General Filling: Plus or minus 1 inch from required elevations.

B. Top Surface of Filling Under Paved Areas: Plus or minus 1 inch from required elevations.

3.06 **FIELD QUALITY CONTROL**

A. See Section 01 40 00 - Quality Requirements, for general requirements for field inspection and testing.

B. Perform compaction density testing on compacted fill in accordance with ASTM D1556.

*An independent Geotechnical Consultant will be hired by the Owner for compaction testing

C. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D 698 (“standard Proctor”).

D. If tests indicate work does not meet specified requirements, remove work, replace and retest.

E. Frequency of Tests: Comply with recommendations of geotechnical engineer.

F. Proof roll compacted fill at surfaces that will be under slabs-on-grade.

G. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to OWNER.

3.07 **CLEANING**

A. Remove unused materials; leave area in a clean and neat condition, properly prepared for subsequent grading operations.

**END OF SECTION**
SECTION 31 23 33 - TRENCHING AND BACKFILLING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Trenching, backfilling and compacting for utilities outside the building.

1.02 RELATED SECTIONS

A. Section 31 20 00 – Earth Moving.
B. Section 31 23 23 - Fill: Backfilling at building and foundations.
C. Section 33 31 11 - Site Sanitary Utility Sewerage Piping.
D. Section 33 41 00 - Site Storm Utility Drainage Piping.
E. Section 33 46 00 - Subdrainage: Filter aggregate and filter fabric for foundation drainage systems.

1.03 REFERENCES


1.04 DEFINITIONS

A. Finish Grade Elevations: Indicated on drawings.
B. Subgrade Elevations: Indicated on drawings.

1.05 SUBMITTALS

A. See Section 01 33 00 - Construction Submittals, for submittal procedures.
B. Materials Sources: Submit name of imported materials source.
C. File Composition Test Reports: Results of laboratory tests on proposed and actual materials used.
D. Compaction Density Test Reports.

1.06 PROJECT CONDITIONS

A. Provide sufficient quantities of fill to meet project schedule and requirements. When necessary, store materials on site in advance of need.
B. When fill materials need to be stored on site, locate stockpiles where designated.
   1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
   2. Prevent contamination.
   3. Protect stockpiles from erosion and deterioration of materials.
C. Verify that survey bench marks and intended elevations for the Work are as indicated.
D. Protect plants, lawns, and other features to remain.
E. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

PART 2 PRODUCTS

2.01 FILL MATERIALS
A. General Fill: Subsoil excavated on-site.
   1. Free of lumps larger than 3 inches, rocks larger than 2 inches, and debris.
B. Modified Subbase Fill: See Section 31 23 23.
C. Granular Drainage Fill: See Section 31 23 23.
E. Topsoil: See Section 31 22 00

2.02 ACCESSORIES
A. Filter Fabric: As specified in Section 33 46 00 - Subdrainage.

2.03 SOURCE QUALITY CONTROL
A. See Section 01 40 00 - Quality Requirements, for general requirements for testing and analysis of soil material.
B. If tests indicate materials do not meet specified requirements, change material and retest.

PART 3 EXECUTION

3.01 EXAMINATION
A. Identify required lines, levels, contours, and datum locations.
B. Locate, identify, and protect utilities that remain and protect from damage.
C. See Section 31 22 00 and 31 23 23 for additional requirements.

3.02 TRENCHING
A. Notify Architect of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.
B. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.
C. Do not interfere with 45 degree bearing splay of foundations.
D. Cut trenches wide enough to allow inspection of installed utilities.
E. Hand trim excavations. Remove loose matter.
F. Remove large stones and other hard matter which could damage piping or impede consistent backfilling or compaction.
G. Remove excavated material that is unsuitable for re-use from site.
H. Stockpile excavated material to be re-used in area designated on site in accordance with Section 31 22 00.
I. Remove excess excavated material from site.

3.03 PREPARATION FOR UTILITY PLACEMENT

A. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.
B. Compact subgrade to density equal to or greater than requirements for subsequent fill material.
C. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.

3.04 BACKFILLING

A. Backfill to contours and elevations indicated using unfrozen materials.
B. Fill up to subgrade elevations unless otherwise indicated.
C. Employ a placement method that does not disturb or damage other work.
D. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.
E. Maintain optimum moisture content of fill materials to attain required compaction density.
F. Granular Fill: Place and compact materials in equal continuous layers not exceeding 6 inches compacted depth.
G. Soil Fill: Place and compact material in equal continuous layers not exceeding 8 inches compacted depth.
H. Slope grade away from building minimum 2 inches in 10ft, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.
I. Correct areas that are over-excavated.
   1. Thrust bearing surfaces: Use structural fill compacted to minimum 98 percent of maximum dry density.
   2. Other areas: Use general fill, flush to required elevation, compacted to minimum 98 percent of maximum dry density.
J. Compaction Density Unless Otherwise Specified or Indicated:
   1. Under paving, slabs-on-grade, and similar construction: 98 percent of maximum dry density.
   2. At other locations: 95 percent of maximum dry density.
K. Reshape and re-compact fills subjected to vehicular traffic.

3.05 BEDDING AND FILL AT SPECIFIC LOCATIONS

A. Utility Piping for water, gas, electrical distribution, storm and sanitary piping:
   2. HDPE Storm Sewer shall have Aggregate material to 12" above top of pipe.
   3. Cover with general fill except storm sewer under pavement shall be backfilled with granular drainage fill to bottom of subgrade elevation.
   4. Fill up to subgrade elevation.
5. Compact in maximum 6 inch lifts to 98 percent of maximum dry density.

B. Over Subdrainage Piping at Foundation Perimeter and Under Slabs:
   1. Granular drainage fill and geotextile fabric: Section 33 46 00.
   2. Cover drainage fill with general fill.
   3. Fill up to subgrade elevation.
   4. Compact to 98 percent of maximum dry density.

3.06 TOLERANCES
   A. Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.
   B. Top Surface of Backfilling Under Paved Areas: Plus or minus 1 inch from required elevations.

3.07 FIELD QUALITY CONTROL
   A. See Section 01 40 00 • Quality Requirements, for general requirements for field inspection and testing.
   B. Perform compaction density testing on compacted fill in accordance with ASTM 01556.
*An independent Geotechnical Consultant will be hired by the Owner for compaction testing.
   C. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D 698 ("standard Proctor").
   D. Frequency of Tests: As recommended by geotechnical engineer.
   E. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to the Owner.

3.08 CLEAN-UP
   A. Remove unused stockpiled materials; leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

END OF SECTION
SECTION 32 11 23 - AGGREGATE BASE COURSES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Aggregate base course for vehicular pavement and sidewalks

1.02 RELATED REQUIREMENTS
A. Section 31 22 00 – Grading: Preparation of site for base course.
B. Section 31 23 23 - Fill: Compacted fill under base course.
C. Section 32 13 13 - Concrete Paving: Finish concrete surface course.

1.03 REFERENCE STANDARDS
B. ASTM D 2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2006.
D. IDOT Standard Specifications Section 4123, Gradation 14 (Modified Subbase).

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Materials Sources: Submit name of imported materials source.
C. Aggregate Composition Test Reports: Results of laboratory tests on proposed and actual materials used.
D. Compaction Density Test Reports.

1.05 DELIVERY, STORAGE, AND HANDLING
A. When necessary, store materials on site in advance of need.
B. When aggregate materials need to be stored on site, locate stockpiles where indicated.
   1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
   2. Prevent contamination.
   3. Protect stockpiles from erosion and deterioration of materials.

PART 2 PRODUCTS

2.01 MATERIALS
A. Modified Subbase: IOWA DOT Gradation 14, Section 4123.
B. Granular Drainage Fill: IOWA DOT Gradation 29, Section 4131.
2.02 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for general requirements for testing and analysis of aggregate materials.
B. Test and analyze aggregate samples for compliance before delivery to site.
C. If tests indicate materials do not meet specified requirements, change material and retest.
D. Provide materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify substrate has been inspected, gradients and elevations are correct, and is dry.

3.02 PREPARATION

A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.
B. Do not place aggregate on soft, muddy, or frozen surfaces.
C. Proof-roll with loaded tandem axle dump truck.
D. Areas where unsuitable conditions exist should be repaired by removing and replacing the unsuitable materials with properly compacted fill.

3.03 INSTALLATION

A. Place aggregate base over compacted subgrade to a minimum compacted thickness of 6 inches.
B. Compact to 98 percent of maximum dry density.
C. Level and contour surfaces to elevations and gradients indicated.
D. Add small quantities of fine aggregate to coarse aggregate as appropriate to assist compaction.
E. Add water to assist compaction. If excess water is apparent, remove aggregate and aerate to reduce moisture content.
F. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

3.04 TOLERANCES

A. Flatness: Maximum variation of 1/4 inch measured with 10 foot straight edge.
B. Scheduled Compacted Thickness: Within 1/4 inch.
C. Variation From Design Elevation: Within 1/4 inch.

3.05 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for general requirements for field inspection and testing.
B. Compaction density testing will be performed on compacted aggregate base course in accordance with ASTM D1556.

*An independent Geotechnical consultant will be hired by the Owner for compaction testing.
C. Results will be evaluated in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D 698 (“standard Proctor”).

D. If tests indicate work does not meet specified requirements, remove work, replace and retest.

E. Frequency of Tests: In accordance with requirements of Geotechnical Engineer, but no fewer than one for each 500 sf.

3.06 CLEANING

A. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

END OF SECTION
SECTION 32 12 16 – HOT MIX ASPHALT PAVEMENT

PART 1   GENERAL

1.01   Section Includes

A. Hot Mix Asphalt (HMA) Full-Depth Pavement.
B. HMA Base Repair and Joint Repair.
C. HMA Overlay.
D. HMA Curb.
E. Fabric Reinforcement.

1.02   Description Of Work

A. HMA Full-Depth Pavement: includes mixing, placing, and compaction of an ACC binder, leveling, surface, or base course as pavement, pavement widening, driveway pavement, pedestrian and/or bike trails including tack coat in accordance with the Contract Documents.

B. HMA Base Repair and Joint Repair: includes mixing, placing, and compaction of an HMA binder, leveling, or base course (base may also be Portland Cement Concrete (PCC)) for the purposes of repairing an existing roadway, including tack coat prior to resurfacing with HMA, in accordance with the Contract Documents. Work under the section also includes:
   1. Full depth pavement repairs to existing PCC or HMA roadways. Work may be prior to resurfacing.
   2. Full-depth and partial depth repairs at existing joints in PCC roadways prior to resurfacing.

C. HMA Overlay: includes mixing, placing, and compaction of HMA for the purposes of repairing an existing pavement with an overlay, including tack coat in accordance with the Contract Documents.

D. HMA Curb: includes mixing, placing, and compaction of HMA for the purposes of constructing curb on an HMA pavement, including tack coat in accordance with the Contract Documents.

E. Fabric Reinforcement: includes furnishing and installing fabric reinforcement, including tack coat, in accordance with the Contract Documents.

1.03   Submittals

A. Submit samples and test results as set forth in the Contract Documents.
B. Submit certificate of compliance indicating the materials incorporated into the Work comply with the Contract Documents.
C. Submit verification of Iowa DOT certification for HMA supplier.
D. Submit job mix test reports conforming to an Iowa DOT certified job mix.
E. Weight receipts shall include mix type, and/or correlate to bid item.
F. Pavement smoothness testing results and certifications.
G. Quality control test reports.
1.04 Delivery, Storage And Handling

A. Excess HMA shall be disposed of in a manner as to not cause damage or harm to adjacent properties or public facilities. Disposal shall be in accordance with applicable local, state and federal regulations.

B. Aggregate Storage: Prevent contamination and intermingling of aggregate stockpiles.

C. Classification of recycled asphalt pavement (RAP) shall be determined by Iowa DOT. Provide appropriate documentation.

1.05 Scheduling And Conflicts

Schedule Work to minimize disruption of public streets and facilities.

1.06 Special Requirements

A. All Work and materials incorporated into this Project shall conform to all applicable local, state, and federal requirements.

B. Before HMA can be placed, the road surface and air temperature must meet the following minimum temperature requirements:
   1. For lower layers of HMA (base, intermediate and leveling course):
      a. For 1½-inch layer, the subbase or road surface shall be a minimum of 40 degrees F.
      b. For 2-3-inch layer, the subbase or road surface shall be a minimum of 35 degrees F.
      c. For 3-inch or greater layer, subbase or road surface shall be 25 degrees F (min).
   2. For all wearing course layers of HMA:

      | Layer thickness (inches) | 3/4 | 1  | 1½ | 2  |
      |--------------------------|-----|----|----|----|
      | Minimum road surface temp (degree F) | 60  | 50 | 45 | 40 |

3. For curbs, the road surface must be a minimum 40 degrees F in shaded areas.

4. For primer and tack coats, the road surface must be a minimum 40 degrees F.

5. The air temperature, including wind chill, shall be a minimum of 40 degrees F and rising for all HMA Paving.

6. The air temperature shall be 50 degrees F and rising unless otherwise approved by the Engineer for tack coat for reinforcing fabric.

7. If other weather conditions are detrimental to the placement of the HMA, the Engineer may consider those factors in determining if the conditions are suitable for the placement of ACC.

8. HMA shall not be placed on a wet surface.

9. If use of Recycled Asphalt Pavement (RAP) is allowed in contract documents, Iowa DOT Standard Specification 2303 governs, except as modified in contract documents.

10. Use of Recycled Asphalt Shingles (RAS) is not allowed.
PART 2 PRODUCTS

2.01 HMA Pavement

A. Materials shall comply with Iowa DOT Standard Specification 2303.02, including current Supplemental Specifications for Hot Mix Asphalt (HMA).

B. Unless otherwise noted on the Contract Documents, the following HMA mixtures shall be used:

1. For base/intermediate courses and base repairs: HMA 1M B ¾ or HMA 1M B ½
2. For leveling courses: HMA 1M S ¾ or HMA 1M I ½
3. For joint repair, surface courses and walks/trails: HMA 1M S ½
4. For HMA Curb: HMA 300K S ¼. Approximately 15 pounds of powdered asphalt shall be added to the mixture for each 100 pounds of asphalt cement incorporated in the mixture. The powdered asphalt shall be solid or hard asphalt, or gilsonite, finely crushed.

C. The Engineer may approve the incorporation of additional mineral filler.

2.02 Bituminous Materials

A. Performance Grade Asphalt: Performance grade asphalt PG 58-28, PG 64-28 or PG 70-28, in accordance with the Iowa DOT Standard Specifications, including Supplemental Specifications.

B. Tack Coat:

1. Emulsified asphalt grade SS-1, SS-1H, CSS-1 or CSS-1H.
2. Emulsified asphalt shall be diluted with an equal volume of water by the manufacturer. Each shipment shall include a certified statement specifying the rate of dilution.
3. Provide Engineer application rate for diluted emulsified asphalt required to achieve undiluted application rate.
4. Mixing of CSS and SS grades will not be allowed.
5. RC-70 and RC-T may be used after October 1, at Contractor’s option.

Prime Coat: Grade MC-70 as specified in the Iowa DOT Standard Specifications.

2.03 Aggregate for HMA

Aggregate for HMA shall meet the requirements of Iowa DOT Standard Specification 4127 Type B (Primary) with the following requirements.

A. Aggregate with a minimum of 70 percent crushed stone particles.

B. Of material delivered to the drier, not less than 25 percent of portion passing No. 4 sieve shall be particles from natural sand.

C. Unless specified otherwise in contract documents, friction requirements do not apply.

2.04 Equipment

A. All equipment used in the Completion of the Work specified herein shall comply with Iowa DOT Standard Specification Section 2303.03.
B. Pavers shall be equipped with a receiving hopper having sufficient capacity for a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed.

C. Bituminous pavers shall be equipped with automatic grade and slope controls. The automatic control system must maintain the screed or strike-off in a constant position relative to profile and cross slope references. While operating automatically it shall be possible to manually override the automatic controls. The references shall be such that control of the screed or strike-off position is reasonably independent of irregularities in the underlying surface and of spreader operations. When paving in widths exceeding the manufacturer’s recommendations for use of the automatic slope control, a grade reference system shall be used on both sides of the paver.

D. The screed or strike-off assembly shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture. Screeds or strike-off assemblies shall extend the full width of the course being laid and shall impart initial compaction thereon. The paver shall be capable of being operated at forward speeds consistent with satisfactory laying of the mixture. Automatic screed controls will not be required on sections of Projects where service road connections or intersections and other conditions interfere with their efficient operation.

E. The HMA mixture shall be transported in clean, metal-bottom vehicles, free from kerosene and other solvents.

2.05 Fabric Reinforcement

A. Grade Fabric.

1. Non-woven polypropylene grade fabric shall be a paving grade fabric currently approved by the Iowa DOT for asphaltic resurfacing.

2. Allowable products include Phillips “Petromat” or an approved equal.

3. Grade Control Fabrics shall have the following properties:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grab Strength, dry, minimum average value in either principal direction</td>
<td>90 lbs</td>
<td>ASTM D4632</td>
</tr>
<tr>
<td>Elongation, dry, minimum average value either principal direction</td>
<td>20 percent</td>
<td>ASTM D4632</td>
</tr>
<tr>
<td>Grab Strength after 400°F for 3 hrs (a), minimum average value in either principal direction</td>
<td>75 lbs</td>
<td>ASTM D4632</td>
</tr>
</tbody>
</table>

(a) Applies only when asphalt temperatures exceeding 300°F are anticipated.

B. Crack Control Fabric.

1. Non-woven polypropylene crack-control fabric shall consist of a rubberized asphalt membrane bonded to a coated non-woven fabric designed to inhibit surface moisture intrusion into pavement base structures. Fabric roll widths shall be as noted in the plans.

2. Allowable products include Phillips “Petrotac” or an approved equal.
3. Crack-control fabrics shall have the following properties:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grab Tensile (lb)</td>
<td>245</td>
<td>ASTM D4632/Iowa 913</td>
</tr>
<tr>
<td>Elongation</td>
<td>80 percent</td>
<td>ASTM D4632/Iowa 913</td>
</tr>
<tr>
<td>Strip Tensile, Modified (lb/inch)</td>
<td>50 minimum</td>
<td>ASTM D882</td>
</tr>
<tr>
<td>Puncture Resistance (lb)</td>
<td>200 minimum</td>
<td>ASTM E154</td>
</tr>
<tr>
<td>Permeance (perms)</td>
<td>0.10 maximum</td>
<td>ASTM E96, Method B</td>
</tr>
<tr>
<td>Pliability, (\frac{1}{4})-inch (Modified) Mandrel, 180° Bend @ -25° F</td>
<td>No cracks in fabric or rubberized asphalt</td>
<td>ASTM D146</td>
</tr>
</tbody>
</table>

C. Ensure asphalt absorption is sufficient to produce a good bond between the overlay and the overlaid surface when a tack coat of 0.20 gallon to 0.25 gallon of asphalt cement per square yard is used. Fabrics such as fiberglass, which do not lend themselves to testing by some of the previously specified methods, may be approved by the Engineer.

D. Uncut paving grade asphalt cements (AC, AR or penetration grade) shall be used as tack coat for the fabric reinforcement. The grade of material will be dependent on availability and the time of year and shall be subject to prior approval by the Engineer.

2.06 Use of Recycled Materials (if allowed in contract documents)


B. Use only classified RAP.

PART 3 EXECUTION

3.01 General

A. The Engineer shall have the authority to shut down paving operations if weather conditions do not allow for proper placement of HMA pavement.

B. No HMA paving of any type shall commence until traffic control is in place in accordance with Section 01200.

C. If Work is to occur within existing public rights-of-way, the Contractor shall be required to obtain all necessary permits and shall be responsible for all applicable fees.

D. The surface of each layer shall be cleaned by the Contractor and kept free from foreign matter when each succeeding layer is placed.

E. All contacting HMA surfaces including curb and gutter sections, shall be coated with tack coat.

F. Tack Coat Application

1. Limit length of application to minimize inconvenience to public.

2. On overlay projects, apply additional tack coat in following areas:

   a. Within 2 feet of curb faces, culvert headwalls and curbs or handrails of bridges.

   b. All runoffs and fillets, including depressed areas around drainage inlets.

G. No HMA pavement shall be placed unless the existing road and air temperatures, as specified in Paragraph 1.06, are satisfied.
H. Side forms, when used, shall be coated with a suitable form oil prior to commencing the paving operation.

I. The Contractor shall adjust fixtures to conform to the proposed finished surface within the area to be paved. The outside of the fixture shall be cleaned to base of pavement before commencing the paving operation. The fixture shall be boxed out if required by the Contract Documents.

J. All utility fixtures in the paved area shall be adjusted to conform to the final adjacent finished surface, in accordance with Contract Documents and Section 02600, where applicable.

K. Traffic shall be permitted on the newly finished surface only when sufficient time lapses to prevent damage to the surface and/or curb from vehicles on it, as determined by the Engineer. Any damaged HMA pavement shall be repaired or replaced by the Contractor, as determined by the Engineer.

3.02 Preparation

A. HMA paving shall not commence until subbase has been prepared as set forth in Section 02100. HMA shall not be placed if subbase is excessively wet, or has a moisture content greater than 2 percent above the optimum moisture content, or if temperature requirements of Paragraph 1.06 in this section are not met.

B. The Contractor is responsible for maintenance of completed subgrade and/or subbase. If rutting or any other damage occurs to the subgrade and/or subbase for any reason, repair immediately. Such repair will include, if necessary, scarifying subgrade to a depth of 8 inches, aerating, and recompacting.

C. Before placing the surface course, clean the underlying base or intermediate course of all loose and foreign material by sweeping with power sweeps equipped with blowers or hand brooms, if necessary. Whenever the surface course is not placed within 24 hours of the underlying base or intermediate course, or the underlying base or intermediate course is determined not to be clean by the Engineer, a tack coat shall be applied to such underlying course as directed and at a rate specified by this section.

D. Remove spalling and scaling material, old patch and joint material, debris, and all other loose material that can be removed by hand tools, such as picks or air blast. Use mechanical hammers when required by the Engineer. On concrete and bituminous surfaces, remove all existing bituminous patch materials that are unstable to the degree that they have distorted under traffic or contain fractures or spalled particles. Bituminous seal coats, or other bituminous layers that may not be as well cured or may be flushed at the surface, but that lack sufficient thickness to cause instability to themselves or the new resurfacing, may be allowed to remain in place. Clean cracks with a width that exceeds ¾ inch to a depth of at least 1 inch, and to a depth up to 3 inches if the material is readily removable. At the time the resurfacing is spread, the entire base shall be made free of foreign material by scrapers, air hoses, or brooming, as necessary.

E. All material removed from the pavement shall remain the property of the Contractor and be removed in accordance with the General Conditions. The Contractor shall remove, by blading, such portions of the earth shoulder that would interfere with placement of base, binder, or surface courses.

F. The Contractor shall mow grass on the shoulder, as required, or otherwise prepare that surface, when a guide string line reference is to be positioned on the adjacent shoulder.

3.03 Delivery

A. Protect HMA with adequate covers while in transit. No batches shall be delivered within 1 hour of sundown or before sunrise, unless otherwise permitted by the Engineer.
B. Deliver HMA to the site in such quantities as to insure continuous paving before the preceding batch or batches have cooled. Before delivery is commenced, the underlying course shall be thoroughly dry and air temperature shall be not less than 40 degrees F., unless otherwise approved by the Engineer.

C. Control all handling and manipulation of the HMA from the mixer to the final spread on the road to maintain a uniform composition and minimize segregation of coarser particles to the extent that it cannot be visibly observed in the compacted surface.

D. Keep production temperature of HMA mixtures between 225ºF and 330 ºF. Do not discharge HMA into paver hopper when its temperature is less than 245 degrees F for a nominal layer thickness of 1½ inches or less and 225 degrees F for a nominal layer thickness of more than 1½ inches.

E. Mixture temperature shall be sufficient to allow for the specified compaction and density to be attained.

F. Keep the paver hopper sufficiently full at all times to prevent nonuniform flow of the mixture through the control gate or channel leading to the augers and screed. Paver wings shall not be dumped until the end of a days production. This material is to be wasted unless use is approved by the Engineer.

G. Except for an unavoidable delay or breakdown, delivery of hot HMA to any individual spreading unit shall be continuous and uniform and at a rate sufficient to provide as continuous an operation of the spreading unit as practical.

H. While operating on the road surface, use of kerosene, distillate, other petroleum fractions, or other solvents, for cleaning hand tools or for spraying the paver hopper will not be permitted. Containers of cleaning solution shall not be carried on or near the paver. When a solvent is used, the paver shall not be used for at least 5 hours after this cleaning. Hand tools shall be kept clean. The Contractor shall be responsible for collecting and removing all cleaning materials and cleaning residue from the Project and plant site. The cleaning material and residue shall become the property of the Contractor.

3.04 Placement of HMA

A. Whenever practicable, spread all HMA by a finishing machine. Irregular areas may be spread by hand methods. Spread the HMA uniformly to the desired depth with hot shovels and rakes. After spreading, smooth the HMA carefully to remove all segregated coarse aggregate and rake marks. Use rakes and lutes designed for use on asphalt mixtures for hand spreading and smoothing.

B. Evenly spread, screed and finish the HMA top course, using suitable power equipment to form uniformly even and dense asphalt concrete pavement of the required thickness after compaction. Place the mixture in strips having a minimum width of 12 feet, where applicable.

C. Unless noted otherwise in Contract Documents, maximum compacted thickness of HMA courses shall be as follows:

1. Base course: 4 inches per lift.
2. Intermediate and/or leveling course: 2 inches per lift.
3. Surface course: 2 inches per lift
D. Unless noted otherwise in contract documents, minimum lift thickness shall be as follows:

<table>
<thead>
<tr>
<th>Design Mix Size (in)</th>
<th>Minimum Lift Thickness (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8</td>
<td>1</td>
</tr>
<tr>
<td>1/2</td>
<td>1 1/2</td>
</tr>
<tr>
<td>3/4</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

E. Placing Leveling Courses.

1. The Contract Documents will show the thickness of the courses to be placed. Depressions or low areas more than 1 inch below the bottom of the intended elevation of the course shall be brought to the elevation of the bottom of the course by placement of preliminary leveling courses of the same mixture specified for the base or intermediate course.

2. When the depth of leveling or strengthening course is more than 2 inches, place in approximately equal layers not exceeding 2 inches thickness to plan depth.

3. When the width of any leveling layer is 8 feet or more, spread the layer by a finishing machine. When placing the mixture, the forward speed of the finishing machine shall be slowed as necessary to provide the least amount of stopping. Other widths and irregular areas may be spread by hand methods.

4. When leveling or intermediate courses must be feather edged, the coarser aggregate shall be raked out and not incorporated. Leveling and intermediate courses shall be compacted.

5. A succeeding layer may be placed as soon as final rolling or tamping on the initial layer is completed. (At any location, not more than 2 successive layers shall be placed in any one working day).

F. Weather Limitations: HMA mixtures shall be placed when the combination of laydown and base surface temperatures are within the limits shown in the following table and in Paragraph 1.06, when the weather is not rainy nor foggy, and when the roadbed is in a satisfactory condition. In case of sudden rain, the placing of mixture then in transit from the plant, if laid at proper temperature and if the roadbed is free from pools of water, may be permitted by the Engineer. Such permission shall in no way relax the requirements for quality and smoothness of finished surface.

<table>
<thead>
<tr>
<th>Base Temp (degrees F)</th>
<th>Pavement Lift Thickness (inches)</th>
<th>1/2</th>
<th>3/4</th>
<th>1</th>
<th>1 1/2</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 - 30</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>305</td>
<td>---</td>
<td>285</td>
</tr>
<tr>
<td>33 - 40</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>310</td>
<td>300</td>
<td>285</td>
</tr>
<tr>
<td>41 - 50</td>
<td>---</td>
<td>---</td>
<td>310</td>
<td>300</td>
<td>295</td>
<td>285</td>
<td>275</td>
</tr>
<tr>
<td>51 - 60</td>
<td>310</td>
<td>300</td>
<td>290</td>
<td>285</td>
<td>275</td>
<td>265</td>
<td>255</td>
</tr>
<tr>
<td>61 - 70</td>
<td>310</td>
<td>300</td>
<td>290</td>
<td>285</td>
<td>270</td>
<td>265</td>
<td>260</td>
</tr>
<tr>
<td>71 - 80</td>
<td>300</td>
<td>290</td>
<td>285</td>
<td>280</td>
<td>270</td>
<td>265</td>
<td>260</td>
</tr>
<tr>
<td>81 - 90</td>
<td>290</td>
<td>280</td>
<td>275</td>
<td>270</td>
<td>265</td>
<td>260</td>
<td>260</td>
</tr>
<tr>
<td>91+</td>
<td>280</td>
<td>275</td>
<td>270</td>
<td>265</td>
<td>260</td>
<td>260</td>
<td>255</td>
</tr>
</tbody>
</table>
G. Unless otherwise permitted by the Engineer, in curbed areas the placing shall begin along the outer lanes on a crowned section or on the high side of a section with a one-direction slope.

H. Succeeding layers of leveling, strengthening, base, intermediate, or surface courses shall not be placed until the previously placed layer is completed for the full width of pavement.

I. At the end of each day’s operations, or when paving is interrupted for a sufficient length of time to allow the mixture to cool below 150 degrees F, a temporary joint shall be made. When paving operations are resumed, the joint shall be cut and trimmed back to expose an unsealed or granular surface for the full depth of the course. The exposed edge of the joint shall then be painted with a thin coat of hot asphalt cement and fresh mixture shall be raked against the joint, tamped and rolled. Hot smoothing irons may be used to seal the joints, at the discretion of the Engineer.

J. The joints between existing asphalt concrete pavement, if any, and asphalt concrete pavement to be furnished and installed under this Contract shall be cut, painted and rolled or sealed in a similar manner.

K. The offset distance between longitudinal joints in succeeding courses of full depth HMA paving shall be not more than 6 inches or less than 3 inches. Transverse construction joints in succeeding courses shall be separated by not less than 6 feet. The spreading of hot mixtures along longitudinal joints shall be adjusted to secure complete joint closure and full compression of the mixture with a smooth surface and joint after compaction. At transverse joints, the cold mixture of the layer shall be sawed to a straight line at right angles to the centerline so that a full thickness, a true surface, and a vertical edge will be provided.

L. In the event the paving machine encounters the problem of mechanical failure of the automatic controls, suspend Work until both the grade and slope controls are in working order.

M. The speed of the finishing machine used shall be such that the number of required stops is minimized.

3.05 Reference System

A. The reference system may be either string line or ski type on all Work except new or stage construction.

B. On new or stage construction, a string line grade reference system shall be used for longitudinal grade control on the first lift of paving except that if a previously placed strip of pavement or other suitable grade reference, such as concrete gutter or a similar item, has been placed to a specified line, grade and cross section and is to adjoin the strip to be placed. The previously placed pavement or other suitable reference may serve as longitudinal grade control reference for the new strip by utilizing a ski or joint matching shoe. Grade reference system for subsequent lifts of paving shall be ski type.

C. Establish the string line reference system; furnish all materials, equipment, labor and incidentals required to construct the string line reference system as described herein and maintain it as long as it is needed. Complete the string line reference system advance of construction to avoid any delay or interruption of laying the pavement. The string line reference system shall consist of suitable wire supported by approved devices compatible with the type of automatic paver control system used. The string line and supports shall be capable of maintaining the line and grade designated by the plans at the point of support while withstand the tensioning necessary to prevent sag in excess of ¼ inch between supports spaced 50 feet apart. Additional supports shall then be installed to provide a minimum spacing of 25 feet (less if directed by Engineer) between same to remove any apparent deviation of the string line from theoretical grade.
3.06 Compaction

A. Compact all HMA lifts to produce a surface free of ridges, marks, or bumps, subject to the approval of the Engineer. Promptly and thoroughly compact each lift. For all rollers, the initial contact with the hot mixture shall be made by the vibratory steel roller roll. Each reverse trip shall lap all but 4 to 6 inches of the previous track. When reversing direction, the initial roller shall stop at an angle with the longitudinal direction. Start rolling as soon as the material will carry the roller without undue displacement. Roller shall be operated continuously at a speed not to exceed 3 miles per hour. A sufficient number of rollers shall be furnished on the Work to adequately handle the output of the plant.

B. Following the initial rolling with a vibratory steel roller, the layer shall be given an intermediate rolling with a pneumatic tired roller, and before the temperature falls below 225 degrees F. The intermediate roller shall cover the entire area not less than 6 times.

C. Final Rolling: Final rolling is defined as the last roller to remove surface marks or irregularities. A steel drum, finish roller shall be used to smooth out all marks in the surface. A vibratory roller in the non-vibratory mode may be used as a finish roller. Do not use pneumatic-tired or vibratory rollers in the vibratory mode as the finish roller.

D. Roll longitudinal joints smooth and even at the time of construction. Except on longitudinal joints and super-elevated curves, roll in a longitudinal direction starting at the edge and working toward the center. The rolling at each pass shall overlap the previous pass by ½ the width of the rear wheel of the roller and each pass shall be of slightly different length. When reversing direction, the initial roller shall stop at an angle with the longitudinal direction.

E. Roller wheels shall be kept clean in a manner approved by the Engineer. Exercise care that the roller remains on the asphalt concrete. Any foreign materials incorporated in the surface shall be cause for rejection of the pavement and its replacement by the Contractor, at his own expense.

1. Any pavement that becomes loose, broken, or mixed with dirt, or which is any way defective, shall be removed and replaced with fresh hot material.

2. The courses along curbs, walls and other places, not accessible to the roller, shall be thoroughly compacted with hand or mechanical tampers.

F. Compaction Requirements

1. For all roadways, use Class I compaction per Iowa DOT Standard Specification 2303.03.

2. Use Class II compaction for paved shoulders, temporary surfaces and other situations where Class I compaction is not specified.

3.07 HMA Base Repair and Joint Repair

A. General

The Work shall be conducted on only one lane at a time unless the road is closed. Unless the road is closed, traffic shall be permitted to use the pavement during construction operations. Conduct all operations to create a minimum of inconvenience to traffic. Adjust work schedule so all excavating, backfilling, compacting, and finishing of each patch will be completed in one day for two lane roads. For roads with multiple lanes in each direction, the Work area may include one lane in each direction or as allowed by the traffic control details. If unforeseen conditions result in excavated sections being left overnight, provide sufficient flaggers, barricades, signage and channelizing devices to warn and direct traffic from the time construction operations stop until they resume.
B. Base Repair

1. On two-way roadways, do not disturb pavement for full- or partial depth repair patches or surface patches unless the patch can be completed before the end of the working day.

2. When specified in the Contract Documents, full- or partial depth repair patches may be PCC, HMA, or a combination. Repair PCC base per Section 02700, Paragraph 3.03 prior to HMA overlay.

3. For HMA repair patches, the final surface of the patch shall be level with, or not more than approximately ¼ inch above surrounding pavement.

4. PCC repair patches shall be cured according to mix type in Section 2700, prior to resurfacing with HMA. Tack the patch area and edges before covering with HMA.

5. Heavy equipment shall not be used adjacent to new concrete until the curing is completed.

C. Partial Depth Joint Repairs.

1. Work applies to spalled PCC and/or HMA at existing transverse or longitudinal joints, at locations identified in Contract Documents or as directed by Engineer.

2. Work shall be performed in accordance with standard details in Contract Documents.

3. Partial depth repairs shall be less than one-half of the slab thickness.

3.08 HMA Overlay

A. Complete all repairs to existing pavement as per the Contract Documents.

B. If required, existing PCC slabs shall be cracked and seated as set forth in Section 02800.

C. When required, place reinforcement fabric as set forth in the Contract Documents.

D. Seal pavement surfaces within three feet of the joint formed at the interface of asphaltic resurfacing and existing PCC or HMA pavement with tack (up to 0.1 gallons/sq. yd.) and sand to the satisfaction of the Engineer. This item includes longitudinal joints where new paving meets existing paving within the traveled portion of the street (away from the curb and gutter). This item also includes sealing cold-joints at intersections between main line asphaltic surface and the asphaltic surface placed in the intersection returns. This requirement does not apply in areas of existing pavement repair (where the pavement thickness is not increased).

E. Longitudinal joints for courses on resurfacing projects shall be constructed directly above the longitudinal joint in the existing pavement.

3.09 HMA Curb

A. Curbs shall not be placed on wet or damp surfaces.

B. Surfaces should be tack coated prior to curb placement.

C. The Contractor shall place the curbs with a machine designed for this purpose. If machine placement is not desirable, the Engineer may approve hand placement.

3.10 Fabric Reinforcement

A. Remove and replace fabric damaged during construction.

B. Placement of all roadway fabrics shall be in accordance with the manufacturer’s instructions and as
directed. Place roadway fabrics either as grade fabric across full width of resurfacing area, or as crack control fabric on joints only.

C. Clean the existing pavement thoroughly. The surface shall be dry and free of dust, dirt, debris and oil. Use a power broom for larger areas. Small areas may be cleaned by hand.

D. Cracks less than 1/8 inch do not need to be filled before application of the tack coat. Fill cracks from 1/8 inch to 3/8 inch with liquid crack sealant. Fill cracks wider than 3/8 inch with a stable crack sealant. Crack sealant containing an emulsified asphalt must be approved by the Engineer.

E. The tack coat for reinforcing fabric shall be applied as follows:
   1. The tack coat for reinforcing fabric will extend 3 inches beyond the fabric on all sides.
   2. Tack coat shall be applied between all fabric overlaps.
   3. Tack coat shall be applied evenly and uniform at a rate of 0.25 gallons per square yard or as specified by the fabric manufacturer.
   4. For large areas, the tack coat shall be applied by a distributor truck.
   5. Tack coat material shall be between 290° F and 325° F when applied.

F. Reinforcing fabric for large areas will be applied using mechanical laydown equipment. The laydown equipment must support the fabric roll, adjust the tension on the fabric and broom fabric into the tack coat. The equipment will have break pawls on both ends of the fabric to balance tension on fabric edges and avoid fabric wrinkles. Hand placement of fabric will be allowed for small areas with approval of the Engineer.

G. Take precautions to avoid wrinkles and to insure that bubbles are removed without breaking the fabric. Cut and lap fabric to provide a smooth surface when bubbles and wrinkles cannot be removed.

3.11 Coatings

A. Thoroughly clean surfaces to be coated of all loose pavement, oils, dirt or other foreign matter.

B. Prime Coating.
   1. If primer is required, the entire exposed surface of the course to be primed and adjacent subgrade for a width of one-foot shall be made free from all loose material. Primer bitumen shall then be applied to the edge slopes of the base and adjacent one-foot of subgrade at a rate of 0.2-0.5 gallons per square yard. When this material has been absorbed and set, primer bitumen shall be applied to the entire surface of the course to be primed to the edges, and to the adjacent one-foot width of subgrade at the rate set forth in the Contract Documents.
   2. The primer bitumen shall be allowed to penetrate for at least 24 hours after application before traffic is permitted upon it or before the next course is placed. If it is not practical to keep traffic off, the Contractor shall apply sand to the surface.
C.  Tack Coating.

1.  Tack coat application on horizontal surfaces shall be in accordance with the following:

<table>
<thead>
<tr>
<th>Material</th>
<th>Spraying temperature (degrees F.)</th>
<th>Application Rate (gallons/sq yd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cut-back Asphalt</td>
<td>RC-70 120 – 190</td>
<td>0.02-0.06</td>
</tr>
<tr>
<td></td>
<td>RC-T  85 – 150</td>
<td>0.02-0.06</td>
</tr>
<tr>
<td>Emulsified Asphalt</td>
<td>SS-1, SS-1H 70 – 140</td>
<td>0.04-0.12</td>
</tr>
<tr>
<td></td>
<td>CSS-1, CSS-1H 70 – 140</td>
<td>0.04-0.12</td>
</tr>
</tbody>
</table>

2. Prior to paving, allow sufficient time for the tack coat to cure until it is tacky to the touch.

3. If tacked surface remains at the end of the day, apply sand to the area to prevent the tack coat from becoming a nuisance to motorists.

4. On roadways being constructed under heavy traffic, safety and convenience to the public without soiling their vehicles shall be a controlling factor when permitted by the Engineer. Tack coats at the rate required by paragraph 3.12.C.1 shall be applied immediately before spreading the HMA mixture. Waiting time for curing before spreading the mixture may be kept at a minimum, and will be subject to the Engineer’s approval. Tack application widths shall be so that approximately one-half the roadway is left open to the public traffic with no tack coat applied to it. Tack coat applications shall be strictly limited in length, to minimize inconvenience to the public. They shall be kept within the hot mixture placing Work area that is controlled by flaggers at each end, and shall be planned so that they will be covered with hot mixture when the Work area is opened to traffic at the end of the day’s Work. If the tack-coated surface becomes dirty from weather or traffic, the surface shall be thoroughly cleaned and, if necessary, retacked.

5. The vertical face of exposed, longitudinal joints shall be tacked as a separate operation, before the closing lane is placed, at a rate from 0.10 to 0.15 gallon per square yard.

6. The vertical surfaces of all fixtures, curbs, bridges, or cold mixture with which the hot mixture will come in contact shall be lightly painted or sprayed to facilitate a tight joint with the fresh mixture, as directed by the Engineer.

7. Areas of final course within 2 feet of headwalls of culverts and curbs or handrails of bridges, including depressed areas around floor drains, and feathered areas along curb and gutter lines and at side street returns shall be tacked at 0.1 gallon per square yard and also be tacked as specified above. Promptly after the sand cover is placed, the entire area shall be covered as completely as possible by two rollings with pneumatic tired equipment. Sand used for this cover will not be paid for but shall be considered incidental to other items.

3.12  Surface Requirements

A. The top surface of asphaltic concrete pavement shall conform to the lines and grades shown on the Contract Drawings, within a tolerance shown in paragraph D below, except that such tolerance will not be permitted in areas of pavements where closer conformance with planned grade and elevation is required for proper functioning of appurtenant structures and drainage involved. All finished concrete slabs shall exhibit positive drainage, without any standing water. The Contractor shall be required to correct areas without positive drainage, using a method approved by the Engineer.

B. Current edition of Iowa DOT Standard Specification 2316 shall apply for pavement smoothness. Applicable schedule, and applicability of incentive/disincentive payments shall be identified in the contract documents.
C. New pavement surfaces shall be flush with existing pavement surfaces.

D. Grading Tolerances.
   1. Pavement and Curbs: ± 0.03 feet.
   2. Walks/Trails: ± 0.10 feet.

3.13 Correction of Defective Work

If, during the progress of construction, it is determined by the Engineer that the subgrade, subbase, or any base course or pavement course has not been compacted and finished by the Contractor to the specified thickness or grade within allowable tolerances, the Contractor shall not proceed with any construction of any subsequent course thereon until appropriate corrective measures satisfactory to the Engineer have been completed by the Contractor, at the Contractor’s cost.

END OF SECTION
SECTION 32 13 13 - CONCRETE PAVING

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Portland Cement Concrete (PCC) Pavement
B. Portland Cement Concrete (PCC) Curbs and Gutters

1.02 DESCRIPTION OF WORK

A. Includes the requirements for the construction of full depth Portland Cement Concrete (PCC) pavement, and concrete curbs and gutters placed upon a prepared or corrected subgrade or previously constructed base or subbase. See Division 31 – Fill and Grading for subgrade and subbase construction specifications. This section shall also include final subgrade/subbase preparation for concrete paving.

1.03 SUBMITTALS

Follow the General Provisions (Requirements) and Covenants, as well as the following:

A. PCC Mix Design: Mixes are Class C as defined in Iowa DOT Section 2301 and Materials I.M. 529. Unless otherwise specified in the contract documents, maturity method for strength determination prior to opening to traffic will be allowed.

1. Two weeks prior to commencing any portland concrete placement, the Contractor shall submit a paving mix design for each different source of aggregate to be used for review and approval by the Engineer. Mixes or mix designs approved by the Iowa Department of Transportation or an independent testing laboratory shall be submitted.

1.04 SUBSTITUTIONS

Follow the General Provisions (Requirements) and Covenants.

1.05 SCHEDULING AND CONFLICTS

Follow the General Provisions (Requirements) and Covenants as well as the following:

Complete elements of the work that can affect line and grade in advance of other open cut construction unless noted on plans.

1.06 RESTRICTIONS ON OPERATIONS

The following shall apply unless specifically modified by the Engineer.

A. Weather Conditions:

1. Do not place concrete when stormy or inclement weather or temperature prevents good workmanship. Aggregates containing frozen lumps shall not be placed, and concrete shall not be placed on a frozen subgrade or subbase. The contractor will take all necessary actions to prevent the pavement from freezing.

a. Concrete placement may commence if the concrete mix temperature is a minimum of 40° and the air temperature is:

   1) After November 15, the air temperature is 36° and falling.

b. Concrete placement will stop when:

   1) After November 15, the air temperature is 37° and falling.
2) After April 15, the air temperature is 32° and falling.
3) With non-reinforced pavement, calcium chloride may be added to the mixing water to hasten initial set, if approved by Engineer.
4) Pavement damaged by inclement weather shall be removed and replaced.

c. For warm weather, restrictions on concrete placement see SUDAS Section 7010, 1.07, D.

B. Cold Weather Temperature Protection:
1. All concrete pavement and curb/gutters, including exposed edges of the slab and curb, shall be cured. In addition, concrete less than 36 hours old shall be protected as follows:

<table>
<thead>
<tr>
<th>Night Temperature Forecast</th>
<th>Type of Protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>35°F to 32°F</td>
<td>One layer of burlap for concrete.</td>
</tr>
<tr>
<td>31°F to 25°F</td>
<td>Two layers of burlap or one layer of plastic on one layer of burlap.</td>
</tr>
<tr>
<td>Below 25°F</td>
<td>Four layers of burlap between layers of 4 mil (100 μm) plastic or equivalent commercial insulating material approved by the Engineer.</td>
</tr>
</tbody>
</table>

2) The protection shall remain until one of the following conditions is met:
   a. The pavement is 5 calendar days old.
   b. Opening strength is attained.
   c. Forecasted low temperatures exceed 35°F for the next 48 hours.
   d. Forecasted high temperatures exceed 55°F for the next 24 hours and subgrade temperatures are above 40°F.

b. Paving operations shall be shut down in time to comply with protection requirements outlined above. In good weather, the header shall be placed at least 45 minutes before sunset. During cold weather, more time must be allowed for finishing and protection. All finishing and covering operations shall be performed prior to darkness. Temperature restrictions and protection requirements may be modified by the Engineer.

b. Equivalent commercial insulating material approved by the Engineer may be used. This material shall be waterproof and have a minimum R value of 0.50. If initial set has not yet occurred, a layer of burlap shall be placed on top of concrete prior to placing insulating blankets.

c. Vertical edges of pavement and back of curbs shall be cured by the same method used for curing the surface.

d. Method of protection and materials used shall maintain the concrete above 40°F.

C. Concrete Evaporation Protection:
1. Hot weather condition is defined as any combination of the following conditions that tend to impair the quality of plastic concrete by accelerating the rate of moisture loss and rate of cement hydration causing thermal shrinkage and resulting in plastic shrinkage cracking or crazing.
   • High Ambient Temperature
   • High Concrete Temperature
   • Low Relative Humidity
   • High Wind Velocity
   • Solar Radiation

2. Concrete evaporation protection will be based on the theoretical rate of surface evaporation when it exceeds 0.1 lbs. per square foot per hour. The National Weather Service’s maximum air temperature, relative humidity and maximum steady wind velocity without gusts, for the date and the location of the paving pour shall be used for the Theoretical Rate of Evaporation Chart.
3. During hot weather conditions the Engineer may restrict concrete placement to early morning or evening hours.

4. Under hot weather conditions the Contractor will advise the Engineer of the results of the theoretical evaporation rate throughout paving operations.

5. The Contractor shall discontinue with placement of the concrete when the theoretical evaporation rate exceeds 0.30 lbs./sq.ft./hr.

6. The protection practice by the Contractor will be as follows for the evaporation rate greater than 0.1 lbs./sq.ft./hr.
   a. Immediately apply an approved evaporation retarder (Polymers) to the concrete pavement and curbs or increase the application cure to 1.5 times the standard specified rate.
   b. Take special precautions to assure that the forms and subgrade are sufficiently moist or protected to avoid lowering the water content at the pavement/subgrade interface. In hot weather conditions the subgrade should also be moistened the evening before operations.
   c. Assure that the time between placing and curing is minimized and eliminate delays.
   d. Moisten concrete aggregates that are dry and absorptive.
   e. Use a fog spray to raise the relative humidity of the ambient air if there is a delay in immediately applying the curing compound.
   f. Minimize solar heat by shading, wetting or covering concrete chutes or other equipment that comes in contact with plastic concrete.
g. If shrinkage cracks should appear during finishing the cracks can be closed by striking each side of the crack with a float and refinishing.

D. Rain Protection:

1. The Contractor shall have available, near the site of the work, materials for proper protection of the edges and surface of concrete. Protective material may consist of sheets of burlap, or plastic film. Planks or other material with suitable stakes that can be used as temporary forms shall also be on hand; Iowa DOT Section 2301.

2. If initial set has not occurred, contractor shall take every precaution necessary to protect the surface texture of the concrete.

3. Failure to properly protect concrete shall constitute cause for removal and replacement of defective pavement, if so determined by the Engineer.

E. Safety Fence for Pavement:

1. At the end of each day's run and at all side streets, the Contractor shall erect and maintain such barriers and fencing as are necessary to protect the pavement from damage.

F. Repair of Pavement:

1. The Contractor shall protect the new pavement and its appurtenances from traffic, both public and that caused by its own employees and agents, at its expense. This includes the erection and maintenance of warning signs, lights, barricades, watchmen to direct traffic, and pavement bridges or crossovers.

2. Any part of the pavement damaged by traffic or other causes occurring prior to final acceptance of the pavement shall be repaired or replaced, at the discretion of the Engineer, at the Contractor's expense.

3. The Contractor shall not operate equipment with metal tracks, metal bucket blades, or metal motor patrol blades directly on new paving. The Contractor shall not unload soil or granular materials, including base rock for storage and future reloading directly onto new paving.

G. Utilities Protection: The Contractor will not start work until all utilities are located.

1. Repairs: When the Contractor disrupts or breaks known utilities of the Jurisdiction or privately owned utilities, such utilities shall be repaired at the Contractor's expense. Unnecessary delays in making repairs shall cause the Engineer to have such repairs made and the cost thereof deducted from the monies due the Contractor.

2. Drains, Pipe, Tiles: Existing subsurface drains, pipe, and tiles, which are disrupted or broken by reason of the construction shall be connected to the storm sewer, or another adequate outlet if storm sewer is not available. Should no outlet be readily available, the Engineer shall determine a suitable solution.

3. Water Stop Boxes and Services: The adjustment of stems and castings and/or repair of those broken or damaged by the Contractor shall be at the contractor's expense. Relocation of stop boxes and services shall be by bid items.

H. Use of Pavement: Time for opening pavement for use is determined by age or by test results from cylinder or beams taken during placement.
<table>
<thead>
<tr>
<th>Class of Mix</th>
<th>Type of Cement</th>
<th>Minimum Age For Opening without Testing</th>
<th>Minimum Compressive Strength (psi)</th>
<th>Minimum Flexural Strength Center Point1 (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Type I</td>
<td>14 Days 2</td>
<td>3,000</td>
<td>500</td>
</tr>
<tr>
<td>B</td>
<td>Type I</td>
<td>14 Days 2</td>
<td>2,400</td>
<td>400</td>
</tr>
<tr>
<td>C</td>
<td>Type I</td>
<td>7 Days</td>
<td>3,000</td>
<td>500</td>
</tr>
<tr>
<td>C</td>
<td>Type III</td>
<td>48 Hours</td>
<td>3,000</td>
<td>500</td>
</tr>
<tr>
<td>M</td>
<td>Type I</td>
<td>48 Hours</td>
<td>3,000</td>
<td>500</td>
</tr>
</tbody>
</table>

1 Optional test method for primary roads
2 Ten days for concrete 8 inches or more in thickness
3 Five days for concrete 9 inches or more in thickness
4 Opening without testing only allowed upon approval of Engineer

Note: Maturity Method may be allowed with approval of the Engineer; Iowa DOT Materials I.M. 383

PART 2 - PRODUCTS

2.01 TYPE OF PAVEMENT

Concrete pavement shall be one of two types, standard or slip form.

A. Standard Concrete Pavement: Standard concrete pavement may be reinforced, or nonreinforced, as noted in the contract documents and shall consist of concrete of the class specified in the contract documents, reinforced as shown in the contract documents, placed within forms, and consolidated and finished by equipment operating on forms.

B. Slip Form Pavement: Slip form pavement may be reinforced, or nonreinforced, and shall consist of concrete of the class specified in the contract documents, reinforced as shown in the contract documents, placed, consolidated, and finished without the use of fixed forms.

2.02 MATERIALS

A. Portland Cement; Iowa DOT Section 4101 and Materials I.M. 401

1. Type I; Normal Portland Cement:
   a. Unless otherwise specified, cement shall meet Type I AASHTO M 85, Type I.
   b. When the addition of fly ash to Type I cement is allowed in accordance with Iowa DOT Section 2301, or AASHTO M 240, Type I (PM) or Type IP, cement may be furnished and used within the same limitations.
   c. The cement content of the concrete shall be that specified for Type I cement.
   d. Use IDOT Class C-3 Mix

B. Mineral Additives:

1. Fly Ash Substitute:
   a. Flyash per Iowa DOT Specifications for highway and Bridge Construction Section 4108 may be substituted for cement at the rates specified in section 2301.04E after notification and authorization by the owner's representative.

C. Fine Aggregate for Concrete, Iowa DOT Section 4110: Clean, hard, durable mineral aggregate particles free from detrimental amount of silt, shale, coal, or organic matters.

1. Natural sand as a result from disintegration of rock through erosional processes.
2. From an approved source of not more than 2% shale and coal particles retained on a No. 16 sieve; not more than 2.5% silt by weight.
3. Gradation: Iowa DOT Section 4109, gradation No. 1.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8 inch</td>
<td>100</td>
</tr>
<tr>
<td>No. 4</td>
<td>90 to 100</td>
</tr>
<tr>
<td>No. 8</td>
<td>70 to 100</td>
</tr>
<tr>
<td>No. 30</td>
<td>10 to 60</td>
</tr>
<tr>
<td>No. 200</td>
<td>0 to 1.5</td>
</tr>
</tbody>
</table>

Engineer may adjust gradation to allow for use of local aggregates.

D. Coarse Aggregate for Concrete, Iowa DOT Section 4115: Coarse aggregate shall consist of crushed stone particles.

1. Abrasion loss, in accordance with AASHTO T 96 shall not exceed 50.
2. Freeze and thaw loss, in accordance with Iowa DOT Test Method 211, Method A, shall not exceed 6%.
3. Objectionable Materials: The percentage of such materials shall not exceed the following percentages:

<table>
<thead>
<tr>
<th>Objectionable Materials</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay lumps</td>
<td>0.5</td>
</tr>
<tr>
<td>Coal and carbonaceous shale</td>
<td>0.5</td>
</tr>
<tr>
<td>Total of all shale, similar objectionable materials, and coal combined.</td>
<td>1.0</td>
</tr>
<tr>
<td>Sticks (wet weight) and other organic materials, except coal.</td>
<td>0.1</td>
</tr>
<tr>
<td>Unsound chert particles retained on 3/8&quot; sieve (Non-structural concrete)</td>
<td>3.0</td>
</tr>
<tr>
<td>Unsound chert particles retained on the No. 4 sieve (Gradation No. 6) (1/2&quot; nominal maximum size)</td>
<td>0.5</td>
</tr>
</tbody>
</table>

NOTE: Chert particles which break into three or more pieces when subjected to the freezing and thawing test will be considered unsound.

Chert in aggregate produced from limestone sources is defined as unsound when any of the fractions of the crushed or uncrushed chert do not meet the soundness requirements.

4. Durability: Soundness - Iowa DOT Test Method 408-A.
   c. Class 2 durability stone shall be used unless stated otherwise in the contract documents or otherwise specified by the Engineer.

5. Gradation: Iowa DOT Section 4109, Gradation No. 3.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1/2 inch</td>
<td>100</td>
</tr>
<tr>
<td>1 inch</td>
<td>95 to 100</td>
</tr>
<tr>
<td>1/2 inch</td>
<td>25 to 60</td>
</tr>
<tr>
<td>No. 4</td>
<td>0 to 10</td>
</tr>
<tr>
<td>No. 8</td>
<td>0 to 5</td>
</tr>
<tr>
<td>No. 200</td>
<td>0 to 1.5</td>
</tr>
</tbody>
</table>

Engineer may adjust gradation to allow for use of local aggregates.

E. Water Requirements: Iowa DOT Section 4102.

F. Air Entrainment Admixture: Iowa DOT Section 4103, Materials I.M. 403, AASHTO M 154.
Provisions shall be made to stir, agitate, or circulate air entraining admixtures prior to use so as to insure a uniform and homogeneous mixture.

G. Admixtures: All liquid admixtures as listed below must meet the following requirements. Other admixtures may be used subject to the approval of the Engineer.


2. Accelerating admixtures (calcium chloride): Iowa DOT Section 2529.

H. Reinforcing Steel:

1. Deformed Bars: Billet steel bar, Iowa DOT Section 4151.
   a. All deformed bars shall be epoxy coated, Iowa DOT Section 4151.
   b. Tie bars shall be bent back reasonably straight. Tie bars broken during rebending shall be replaced by the Contractor at no cost by drilling a hole and setting the bar in epoxy. Tie bars shall meet the requirements of ASTM A 615 Grade 40 or 60.
   c. All damage to epoxy coated bars shall be repaired by an approved patching material.

   I. Metal Keyways: Iowa DOT Section 4191

J. Supports for Reinforcing Steel: Iowa DOT Section 2301.

K. Joint Fillers and Sealers:

1. Contraction Joint Sealers: Material for sealing sawed contraction and center line joints and other joints, as shown in the contract documents, shall meet the following requirements:
   a. Poured Joint Sealer: Iowa DOT Section 4136.

2. Preformed Expansion Joint Filler and Sealer: Preformed material for filling expansion joints shall be one of the following types. When the type is not specified, resilient filler shall be used.
   a. Resilient Filler: Iowa DOT Section 4136, AASHTO M 213.
   b. Polyethylene Joint Filler: Iowa DOT Section 4136, AASHTO T 42.
   c. Elastomeric Joint Seals: Iowa DOT Section 4136, AASHTO M 220.

L. Liquid Curing Compounds: Iowa DOT Section 4105, AASHTO M 148.

M. Burlap Covering: Iowa DOT Section 4104.

1. Jute and manilla fibers shall weigh not less than 10 ounces per square yard.

2. Shall be new material or reclaimed material which shall not have a deleterious affect upon fresh concrete.

2.03 MIXES: IOWA DOT Materials I.M. 529

A. Mix Design: Unless otherwise specified, the mix design shall be Class C mix with air entraining. Unless otherwise specified, the minimum compressive strength of the mix shall be 4,000 pounds per square inch at 28 days.
B. Concrete Mixes: Shall meet the following design targets, as per Iowa DOT Section 2301 and Materials I.M. 529.

<table>
<thead>
<tr>
<th>Mix</th>
<th>W/C Basic</th>
<th>W/C Max.</th>
<th>Cement Min.</th>
<th>Water</th>
<th>Entrained Air</th>
<th>Fine Aggregate</th>
<th>Course Aggregate</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-4</td>
<td>0.474</td>
<td>0.532</td>
<td>0.108</td>
<td>0.161</td>
<td>0.060</td>
<td>0.335</td>
<td>0.336</td>
</tr>
<tr>
<td>B-4</td>
<td>0.536</td>
<td>0.600</td>
<td>0.093</td>
<td>0.157</td>
<td>0.060</td>
<td>0.345</td>
<td>0.345</td>
</tr>
<tr>
<td>C-3WR</td>
<td>0.430</td>
<td>0.489</td>
<td>0.108</td>
<td>0.146</td>
<td>0.060</td>
<td>0.309</td>
<td>0.377</td>
</tr>
<tr>
<td>C-4</td>
<td>0.430</td>
<td>0.488</td>
<td>0.118</td>
<td>0.159</td>
<td>0.060</td>
<td>0.331</td>
<td>0.332</td>
</tr>
<tr>
<td>C-4WR</td>
<td>0.430</td>
<td>0.489</td>
<td>0.112</td>
<td>0.151</td>
<td>0.060</td>
<td>0.339</td>
<td>0.338</td>
</tr>
<tr>
<td>M-4</td>
<td>0.328</td>
<td>-------</td>
<td>0.156</td>
<td>0.161</td>
<td>0.060</td>
<td>0.312</td>
<td>0.311</td>
</tr>
<tr>
<td>O-4WR</td>
<td>0.327</td>
<td>-------</td>
<td>0.156</td>
<td>0.160</td>
<td>0.060</td>
<td>0.312</td>
<td>0.312</td>
</tr>
</tbody>
</table>

(1) Concrete Base, temporary pavement, or recreation trails only.

(2) Temporary or recreation trails only.

Other approved mixes will follow Iowa DOT Materials I.M. 529.
As per Iowa DOT Sections 2301, 2511, 2512, 2529, and 2530.

* The initial values for fresh concrete listed in the table above account for anticipated air loss during consolidation of concrete during placement and paving. Actual air loss and target value for air content of fresh concrete are established below.

** Prior to addition of Calcium Chloride

C. Use of Fly Ash: The Contractor shall notify the Engineer prior to making concrete mixture changes which have been approved. Mix proportions for the various mixes using fly ash are included in the Iowa DOT Materials I.M. 529.

The following fly ash substitution rates shall replace those given in Iowa DOT Section 2301 and as referenced in Iowa DOT Materials I.M. 529:

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Cement Type</th>
<th>Fly Ash Substitution Rate by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>March 16 through September 14 ***</td>
<td>Type I and Type II</td>
<td>Not more than 20%</td>
</tr>
<tr>
<td>March 16 through September 14 ***</td>
<td>Type IP and Type I(PM)</td>
<td>Not more than 5% *</td>
</tr>
<tr>
<td>September 15 through October 15</td>
<td>Type I and Type II</td>
<td>Not more than 15%</td>
</tr>
<tr>
<td>September 15 through October 15</td>
<td>Type IP and Type I(PM)</td>
<td>None</td>
</tr>
</tbody>
</table>
October 16 thru March 15 | Type I, Type II, & Type III Type IP and Type I(PM)** | None
March 16 thru October 15 | Type I, Type II, or Type III used in class M mixtures | Class C fly ash only at not more than 10%

* Note: If the cement manufacturer provides the Engineer with satisfactory concrete strength and freeze-thaw durability test results equivalent to concrete with the same Type IP or Type I(PM) cement without fly ash, the substitution rate may be increased to 10%. The testing and acceptance criteria shall be in accordance with Iowa DOT Materials I.M. 401.

** Note: Proportions of Type IP and Type I(PM) shall be increased 15%, by weight, during this time period.

*** Note: The March 16 through September 14 substitution rate may be used at any time the maturity method for monitoring concrete strength is utilized.

Fly ash shall be transported, stored, hauled, and batched in such a manner to keep it dry.

**2.04 MIXING EQUIPMENT**


**2.05 CONCRETE BATCHING: IOWA DOT Section 2301**

A. Plant batching shall be Iowa DOT calibrated and approved. Provide copy of current calibrations and approvals.

**2.06 CONCRETE MIXING**

A. Ready Mixed Concrete: Iowa DOT Section 2301.13
B. All Methods: Each truck load shall be identified by a plant charge ticket showing plant name, contractor, project data, quantity, class, time batched, and water added at site.

**2.07 CONCRETE PLACEMENT EQUIPMENT: IOWA DOT Section 2301.07**

A. Subgrade Finishing Equipment: Use mechanical excavating equipment designed for this purpose, approved by Engineer.
   1. Form line or path area for slip-form paving machine shall be constructed to final grade by form-line excavating equipment with automatic grade controls.
   2. Subgrade between forms or between path areas for slip-form machines constructed to final grade with automatically controlled subgrade excavating machine.

B. Side Forms: Steel, minimum thickness: 5 gage, height at least equal to design thickness of pavement with base width at least 6 inches.
   1. Minimum section length: 10 feet, joint connections designed to permit horizontal and vertical adjustment with locking device to hold abutting sections firmly in alignment.
   2. Bracing, support, and staking must prevent deflection or movement of forms.

C. Flexible Forms: Use steel or wood flexible forms for curves with radius less than 100 feet.
   1. Bracing, support, and staking must prevent deflection or movement of forms.
   2. Forms used to form back of curbs at returns shall have height at least equal to design thickness of pavement and curb height.
3. Forms must be free from scale and surface irregularities; coat with release agent (see Section 7010, 3.03.G) prior to concrete placement.

D. Consolidating and Finishing Equipment: Fixed form or slip form paving machines specifically designed for placing, striking off, consolidating, and finishing in single pass to required cross section.

1. Consolidation of concrete by single pass of approved surface, tube, or internal vibrator operated in accordance with manufacturer's recommendations.

2. Slip form equipment: Automatic horizontal and vertical controls required; equipment must spread concrete to uniform depth prior to finishing.

3. Air screeds and vibrating screeds are approved consolidating and finishing equipment for cul-de-sacs, drives and some intersections. Small runs of pavement up to 250 feet maximum may also require screeds if paving machines are not practical.

4. Equipment subject to approval of Engineer.

E. Hand Finishing Equipment: Contractor shall provide tools including wood or magnesium floats, wood hand floats, point trowels, edgers, or other equipment necessary for proper finishing of concrete.

1. Provide 2 light straightedges, 10 feet long, with handles not less than 12 feet long for use in detecting irregularities in surface; provide 2 heavy straightedges of similar size for use in correcting surface; provide 2 light straightedges 10 feet long for checking curb and gutter line.

2. Provide approved vibrators for consolidating concrete.

3. Provide metal or wood screed true to crown.

F. Curing Equipment: Use pressure sprayer capable of applying a continuous uniform film of curing compound.

G. Concrete Saws: Power operated concrete saws capable of cutting hardened concrete neatly.

H. Joint Sealing Equipment: Equipment capable of heating and installing sealant in joints in accordance with manufacturer's recommendations.

PART 3 – EXECUTION

3.01 FINAL SUBGRADE/SUBBASE PREPARATION

A. Natural Subgrade:

1. Subgrade construction shall be in accordance with Section 31-2323.

2. Subgrade Loading:

   a. Where concrete trucks must travel on a prepared soil-type subgrade to unload and, as approved by the Engineer, watering of the subgrade must be limited to just ahead of the paving machine.

   b. Repetitive loading on the subgrade by concrete trucks shall be minimized by entering and exiting the subgrade on side streets.

   c. Loads in excess of the legal axle load shall not be allowed on the completed subgrade.
d. Partially loaded trucks may be required.
e. If subgrade/subbase failure occurs, the repair shall be coordinated with the Engineer.

3. Maintenance of Subgrade:
   a. The Contractor is responsible for maintenance of the completed subgrade during subsequent construction activities.
   b. Before allowing hauling equipment to use the completed subgrade, the Contractor must be satisfied as to the effect this hauling equipment may have on the partially completed work.

B. Granular Subbase:
   1. Granular subbase for pavements shall be in accordance with Section 32-1123
   2. Should the Contractor who constructed the subbase elect to overbuild the subbase, the paving contractor shall trim down to the design elevation and shape to the final template with an automatically controlled trimming machine.
   3. Excess material shall be salvaged and spread for use on any other approved project location or operation.
   4. The top 1 inch of the subbase shall be uniformly moist prior to paving.
   5. The paving operation shall be suspended where subbase stability has been lost.

3.02 SURFACE FIXTURE ADJUSTMENT

A. Adjust manhole frames and other fixtures within area to be paved to conform to finished surface.

B. Clean outside of fixture to depth of pavement before concrete placement.

C. Box out fixtures for later adjustment where allowed. Size and shape of box out for intakes as shown in Standard Drawings.

3.03 FORMS SETTING

A. Use form line excavating machine to establish subgrade of forms.

B. Set base of forms at or below subgrade elevation with top of forms at pavement surface elevation.

C. Extra height forms with Engineer approval may be used to back up integral curb and paving slab; set base at or below subgrade elevation with top of form at top of curb elevation.

D. Secure forms in place to required grade and alignment.

E. If voids occur under forms, remove forms and rework subgrade to proper elevation and density; reinstall forms.

F. If the soil supporting the form is softened by rain or standing water so that form is inadequately supported, remove forms and rework subgrade to proper elevation and density; reinstall forms.

G. Coat forms with release agent before concrete is placed.
H. Place forms true to alignment and free of latent concrete.

3.04 REINFORCING PLACEMENT

A. Reinforcing metal shall be clean, straight, free from distortion and rust, and shall be firmly secured in position as detailed.

B. All reinforcing metal shall be placed in approved storage to prevent damage; do not distribute along the work site except as needed to avoid delay in paving.

C. Place reinforcing steel as shown on the detailed drawings or as specified; support and secure bars by approved chair and wire assemblies; bars to be checked by the Engineer upon notification from the Contractor.

D. Joint Steel:

1. Tie bars for all longitudinal joints shall be installed so as to be in the intended position in the completed pavement. Tie bars for all longitudinal joints shall be positioned on chairs and secured against movement with metal stakes during placing and finishing of concrete unless otherwise approved by the Engineer. If approved by the Engineer, bars may be placed in position by a machine or other method. For tie steel that is placed mechanically in plastic concrete, the Engineer shall:
   a. Manually check locations and depth of the steel in the plastic concrete behind the slip form paver using the following frequencies:
      - once every 200 lineal feet for tangent roadway sections
      - in at least three locations within all horizontal curve sections
      - for each inspection, at least two tie steel locations within a panel
   b. Using a magnetic locator, verify locations of tie steel in hardened concrete every day. Check out-of-tolerance tie steel to identify the extent of the problem for a retrofit correction.

2. The Contractor shall provide adequate means to ensure that the load transfer devices and tie bars for key type joints are properly secured to maintain correct position and alignment during the placement of concrete.

E. Dowel Holes:

1. Holes for both deformed and smooth dowel bars shall be drilled into the face of the existing slab at midpoint.

2. Drills used to make holes shall be held in a rigid frame to assure proper horizontal alignment with misalignment not to exceed 1/4 inch in the vertical or horizontal plane.

3. The equipment used shall be operated so as to prevent damage to the pavement being drilled. The drilling procedure shall be approved by the Engineer. The hole shall be blown clean to eliminate all dust.

4. Dowels shall be epoxied into place in the existing slab. Epoxy bonding compound shall meet requirements of Section 7010, 2.02, P.

3.05 CONSTRUCTION OF JOINTS

A. General:

1. Longitudinal and transverse joints shall be constructed of the type, dimensions, and at the locations required, as described by these specifications, or as detailed by the plans or
special provisions.

2. Longitudinal joints shall be coincident with or parallel to the pavement center line unless shown otherwise on the plans.

3. All transverse joints shall be at right angles to the center line and shall extend the full width of the pavement unless otherwise specified.

4. All joint fillers shall be installed as shown in the contract documents.

B. Expansion Joint:

1. Install expansion joints between new pavement construction and the faces of buildings, stoops, existing slabs, and other fixtures and as shown on Standard Drawings. Expansion joints shall be preformed foam expansion joint material. Joints at these locations shall be sealed with a self-leveling polyurethane.

C. Saw Joints:

1. Joint locations shall be chalked with a string line before sawing.

2. Joint dimensions:
   a. All transverse contraction joints shall be sawed at a maximum spacing of 12 feet. All joints shall be sawed to a depth as shown on the drawings.

3. In order to prevent shrinkage cracks, sawing shall be commenced promptly after the pavement has obtained sufficient strength to resist tearing of the concrete adjacent to the joint during the process of sawing.

4. Longitudinal joints shall be sawn within 24 hours of the concrete being placed.

5. If necessary, the sawing operations shall be carried on both day and night.

D. Construction Joints:

1. Longitudinal or transverse construction joints shall be placed between adjacent lanes of concrete and at end-of-day header runs.

2. Manhole boxouts shall be located and placed on grade prior to paving. Manhole boxouts are required for two piece castings for sanitary/storm manholes.

3. The longitudinal construction joints shall be an approved key type joint with legs unless machine placed.

3.06 CONCRETE PAVEMENT PLACEMENT

A. Set survey control stakes at 25 foot maximum spacing including high and low points. Additional staking may be required by the Engineer.

B. The concrete shall be placed, consolidated, and finished to the widths and depths outlined in the plans.

C. Integral curbs shall be poured with the slab in a single paving machine operation. Normal mainline paving will not have construction joints at integral curbs.

D. Concrete shall be deposited to the full depth of the pavement in a single operation.

E. Necessary hand spading and spreading shall be done with shovels and not rakes.
F. Place concrete to full depth in single operation. Keep a uniform pile of concrete in front of the paving machine, up to a maximum of 6 to 8 inches above the design surface elevation.

G. The concrete shall be distributed and spread as soon as placed. A mechanical concrete spreader may be used.

H. Concrete Screed:
   1. The concrete shall then be struck off and screeded by mechanical means.
   2. The striking off or screeding shall conform to the crown and cross section shown on the plans.

I. The top of the forms shall be kept clean from accumulations of concrete, and the travel of the finishing machine on the forms shall be maintained true without lift, wobbling, or other variations tending to affect precision of finish.

J. When finishing by hand methods, concrete shall be consolidated by use of vibrating units operating in the concrete. Unless the vibrating apparatus is such that the full width of concrete is consolidated in a single passage, a definite system or pattern shall be used in the operation of the vibrator so the full width of concrete in each linear foot of lane will receive adequate and uniform consolidation. The system and methods of vibrating shall be subject to approval the Engineer. Vibrating equipment shall meet the requirements of IDOT Section 2301.07. Vibrating equipment shall, under no circumstances, be used as a tool for moving concrete laterally on the grade.

3.07 FINISHING

A. Grade and Crown: Promptly after concrete has been placed and vibrated, the surface shall be struck off to the true section by the screed. The surface shall be finished true to crown and grade.

B. Watering the Surface: The practice of lubricating the pavement surface with wet burlap or by sprinkling water from brushes or from sprinkler containers to afford greater ease in finishing operation shall not be allowed.

C. Floats: Finish surface with wood or magnesium floats; finish from both sides simultaneously if pavement is placed to full width with one pass of paving machine.

D. Straight Edging:
   1. After the longitudinal floating has been completed and the excess water has been removed, and while the concrete is still plastic, the slab shall be tested for trueness with a channel radius float, or approval equal. ("channel radius float" is manufactured by Owens Industries, Inc.)

   2. The channel radius float shall be held in successive positions parallel to the road center line in contact with the surface and the whole area worked from one side of the slab to the other as necessary.

   3. Advancement along the pavement shall be in successive stages of not more than one half the length of the channel radius float.

   4. Any depressions found shall be immediately filled with freshly mixed concrete, struck off, consolidated, and refinished.
5. Check surface longitudinally while concrete is still plastic; correct any surface deviations greater than 1/8 inch in 10 feet. Round edges of pavement to 1/8 inch radius.

E. Surface Treatment:

1. Dragged Surface Treatment: Unless otherwise specified, the finished surface shall be textured with a dragged surface treatment

   a. Astroturf or burlap shall be dragged longitudinally over the finished surface to produce a tight, uniform, textured surface, and the edges shall be rounded in a workmanlike manner.

   b. The Astroturf or burlap drag shall be removed from the pavement surface at regular intervals and cleaned with water to remove accumulated concrete from the fabric in order to maintain a consistent finished texture.

   c. When, for any reason, the desired texture normally obtained by the drag is not secured, the Engineer may require that the final finish be a broom finish, in lieu of or in addition to the drag.

F. Edge Finish: Before the concrete has taken its initial set, all edges of the slab shall be carefully finished with an edging tool and the pavement shall be left smooth and true to line and grade.

3.08 SURFACE CURING

A. Apply liquid curing compound in a fine spray to form a continuous, uniform film on the horizontal surface and vertical edges of pavement, curbs and back of curbs immediately after surface moisture has disappeared, but no later than 30 minutes after finishing. With approval of the Engineer, the timing of cure application may be adjusted due to varying weather conditions and concrete mix properties to ensure acceptable macrotexture is achieved.

   1. Use a white pigment liquid curing compound for concrete not receiving an asphalt overlay.

B. Apply compound with power sprayer; rate of application not less than 0.067 gallon per square yard (15 square yards per gallon); do not dilute compound.

C. If forms are used, apply to pavement edges and back of curbs within 30 minutes after forms are removed.

D. Protect concrete pavement during cold weather for at least 5 days, or protect a minimum of 24 hours and flexural strength of 500 psi. See Section 7010, 1.07.

3.9 JOINT SEALING

A. Timing:

   1. Unless otherwise provided, before any portion of the pavement is opened to the Contractor's forces or to general traffic, joints that require sealing shall be sealed.

B. Cleaning:

   1. For those joints that are not to be sealed, cleaning is not required.

   2. For those joints that are to be sealed, the residue from sawing shall be removed from the crack. An air compressor that provides moisture-free and oil-free compressed air shall
be used. Removal of wet-sawing residue by flushing with high pressure water may be necessary prior to blowing the crack clean.

3. Joint Sealer:
   a. Joint sealer shall be prepared and installed in the joint and to the proper level as shown in the contract documents and as recommended by the manufacturer.
   b. Hot-poured sealers shall be heated in a thermostatically controlled heating kettle; the material shall be heated to the temperature required for use, but not above that recommended by the manufacturer. After sealing, excess sealer shall be removed from the pavement surface.
   c. Joint sealer shall be placed only when the pavement and ambient air temperatures are 40° or higher. When near this minimum, additional air blasting or drying time or both may be necessary to assure a satisfactory bond to the joint surfaces.
   d. Joints shall be sealed the same day they are cleaned. Sealing shall be done only when the joint surfaces appear dry by visual examination.

3.10 FORM REMOVAL

A. Timing:
   1. Forms shall not be removed before the initial set of the concrete has taken place.
   2. Remove stakes and forms with care to prevent cracking, spalling, or over stressing concrete. If damage does occur, the minimum repair shall be to saw cut full depth and remove a 4 by 2 \(\frac{1}{2}\) feet wide area, dowel into adjoining sound concrete and pour back full depth; or as required by the Engineer.
   3. Clean forms before resetting.

B. Honeycomb Repair:
   1. When the side forms are removed, honeycomb shall be filled with mortar composed of 1 part cement and 2 parts fine aggregate by weight.
   2. If the honeycombing is to the degree and nature that it is considered by the Engineer as defective work, it shall be removed and replaced at the expense of the Contractor.

C. Paving Protection: The area behind the curbs and slab shall be backfilled immediately after the forms are removed. Dams or other protection shall be constructed to insure that no saturation or erosion of the subgrade under or near the pavement shall occur. This may include check dams, pumping, etc.

3.11 NOT USED

3.12 DEFECTS OR DEFICIENCIES

A. Pavement containing excessive cracks, fractures, spalls, or other defects shall be removed and replaced or repaired at no cost to Jurisdiction. Remedy to be determined by Engineer. In lieu of the above, the Engineer may approve an extended warranty.

B. Pavement Thickness Deficiency: See SUDAS Section 7010, 1.08.

3.13 REMOVAL OF PAVEMENT

A. Comply with Iowa DOT Section 2510.

END OF SECTION
SECTION 32 17 23.13 - PAINTED PAVEMENT MARKINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Parking lot markings, including parking bays, crosswalks, arrows, handicapped symbols, curb markings, light pole bases.

1.02 RELATED REQUIREMENTS

A. Section 32 1313 - Concrete Paving.

1.03 REFERENCE STANDARDS


1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

1.06 FIELD CONDITIONS

A. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.01 MATERIALS

A. Pavement markings shall be only fast dry traffic lane marking paint conforming to Iowa DOT Standard specifications for Highway and Bridge Construction, Section 4183.03
   1. Parking lot striping, direction arrows, light pole bases, sidewalk curbs: Yellow.

PART 3 EXECUTION

3.01 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

3.02 PREPARATION

A. Allow new pavement surfaces to cure for a period of not less than 14 days before application of marking materials.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
C. Clean surfaces thoroughly prior to installation.
   1. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods.

D. Where oil or grease are present, scrub affected areas with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application; after cleaning, seal oil-soaked areas with cut shellac to prevent bleeding through the new paint.

3.03 INSTALLATION

A. Do not apply paint if temperature of surface to be painted or the atmosphere is less than 50 degrees F or more than 95 degrees F.

B. Apply in accordance with manufacturer's instructions using an experienced technician that is thoroughly familiar with equipment, materials, and marking layouts.

C. Comply with FHWA MUTCD manual (http://mutcd.fhwa.dot.gov) for details not shown.

D. Apply markings in locations determined by measurement from survey control points; preserve control points until after markings have been accepted.

E. Apply uniformly painted markings of color(s), lengths, and widths as indicated on the drawings true, sharp edges and ends.
   1. Apply paint in one coat only.
   2. Wet Film Thickness: 0.015 inch, minimum.
   3. Length Tolerance: Plus or minus 3 inch.

F. Parking Lots: Apply parking space lines, entrance and exit arrows, painted curbs, and other markings indicated on drawings.

G. Symbols: Use a suitable template that will provide a pavement marking with true, sharp edges and ends, of the design and size indicated.

3.04 DRYING, PROTECTION, AND REPLACEMENT

A. Protect newly painted markings so that paint is not picked up by tires, smeared, or tracked.

END OF SECTION
SECTION 32 18 16.13 - PLAYGROUND PROTECTIVE SURFACING

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Playground safety surfacing.
   B. Subbase under playground safety surfacing.
   C. PCC Curb Edge.

1.02 RELATED REQUIREMENTS
   A. Section 11 68 13 - Playground Equipment: Playground layout (staking).

1.03 REFERENCE STANDARDS
   C. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN m/m³)); 2012.

1.04 DEFINITIONS
   A. Use Zone: The area beneath and immediately adjacent to a play structure or equipment (play event) that is designated for unrestricted circulation around equipment, and on whose surface it is predicted that a user would land when falling from or exiting the equipment.
   B. Critical Fall Height: The maximum fall height at which the protective surfacing meets the requirements of ASTM F1292.
   C. Fall Height: The vertical distance between the finished elevation of the designated play surface and the finished elevation of the protective surfacing beneath it as defined by ASTM F1487.
   D. Protective Surfacing: Resilient ground surfacing. The characteristics of the protective surfacing are based on the fall height of the playground equipment. Changes in either the surfacing or the fall height, particularly reducing the resilience of the protective surfacing or increasing the fall height, will reduce safety-related performance.
   E. Aggregate Base: A layer under the resilient layer of the protective surfacing but over the subgrade.
   F. Subgrade: The surface of the ground on which the aggregate base is installed.

1.05 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements - Administrative Requirements, for submittal procedures.
   B. Product Data: For all manufactured surfacing products, provide manufacturer's product data showing materials of construction, compliance with specified standards, installation procedures, and safety limitations.
1. Include IPEMA certifications where required.
2. For natural surfacing materials, provide supplier's certification or mill certificate showing compliance with specified requirements.
3. Treated Wood Products: Provide information on wood treatment chemical content, toxicity level, and life-cycle durability.

C. Shop Drawings: Detailed scale drawings showing locations of proposed playground equipment and exposed footings, bases, and anchorage points.
   1. Clearly identify footing and base elevations in relation to a fixed survey point on site and to subgrade elevation and depth of protective surfacing, surveyed by land surveyor licensed in the State in which the Project is located.
   2. Show locations of underground utilities, storm-drainage system and irrigation system.
   3. Show locations of related construction such as walkways, fences, site furnishings, and plantings.
   4. Show measured fall height for each playground equipment item, determined in accordance with ASTM F1487.
   5. Show Use Zone perimeters, determined in accordance with ASTM F1487.

D. Samples: For each product specified.

E. Percolation Test Report: Describing test method used and results.

F. Maintenance Data:
   1. For manufactured surfacing products, provide manufacturer's recommended maintenance instructions and list of repair products, with address and phone number of source of supply.
   2. For loose fill surfacing products, provide detailed re-ordering information to enable Owner to match installed material exactly.

G. Manufacturer's Field Report.

1.06 QUALITY ASSURANCE

A. Maintain one copy of the latest edition of ASTM F1487 and CPSC Pub. No. 325 at project site.

B. Manufacturer Qualifications: Company regularly engaged in manufacturing products specified in this section, with not less than three years of documented experience.
   1. Surfacing installed in minimum 10 sites and been in successful service minimum 5 years.
   2. Provide certificate of Insurance AA rated for minimum 1,000,000 dollars covering both product and general liability.
   3. Manufacturer's Representative: Provide name, company name and address, and qualifications.

C. Installer Qualifications: Company certified by manufacturer for training and experience installing the protective surfacing; provide installer's company name and address, and training and experience certificate.

1.07 PRE-INSTALLATION MEETING

A. Coordinate with Section 11 68 13.

B. Convene a meeting one week before starting earthwork for playground to discuss coordination between various installers.
   1. Require attendance by personnel responsible for grading and installers of playground equipment, protective surfacing, footings, and adjacent work.
   2. Include representatives of Contractor.
   3. Notify Architect at least 2 weeks prior to meeting.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver, handle, and store protective surfacing to project site in accordance with manufacturer's recommendations.

B. Store materials in a dry, covered area, elevated above grade.
1.09 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals - Closeout Submittals, for additional warranty requirements.
   B. Provide minimum 10 year warranty for safety tile playground surfacing.

PART 2 PRODUCTS

2.01 DESIGN CRITERIA
   A. Because the safety of the playground depends on strict conformance to the design criteria, this information is provided for Contractor's information.
      1. The protective surfacing constitutes a resilient layer installed over an aggregate base, which is installed over the subgrade, with the top of playground equipment footings and anchorage devices covered by full depth of the resilient portion of the protective surfacing.
      2. The top elevation of the protective surfacing is intended to be flush with adjacent grades.
      3. Use Zone: The protective surfacing has been designed to provide acceptable impact attenuation as defined in ASTM F1292 for the Critical Heights specifically required for each piece of equipment.
   B. If deviation from specified depth is required, it is the Contractor's responsibility to make all changes required to maintain specified top elevation and required impact attenuation at no extra cost to Owner; obtain approval prior to proceeding; follow approval request procedure as specified for substitutions.

2.02 MATERIALS
   A. Safety Tile Playground Surfacing: Factory-molded rubber tile with impact attenuating design and solid, uniform top surface; adhered to a rigid subbase.
      1. Tile Size: 24 inches by 24 inches.
      2. Coefficient of Friction, when wet: 0.8, minimum, when tested in accordance with ASTM D2047.
      3. Resilient Depth: As required to achieve specified Critical Fall Height as defined in ASTM F1292 but not more than depth indicated; maintain top elevation flush with adjacent grades.
      5. Certification: Provide IPEMA certification of ASTM F1292 Critical Fall Height at thickness specified.
      6. Product: DuroMat Extended Life Playground Tiles manufactured by National Playground Compliance Group, LLC.
         a. Substitutions: See Section 01 60 00 - Product Requirements
   B. Engineered Wood Fiber Playground Surfacing: Manufactured for the purpose of protective surfacing; complying with ASTM F1951 and ASTM F2075; do not use mulch manufactured from recycled pallets, or lumber containing nails or metal fasteners.
      1. Depth: As required to achieve specified Critical Fall Height as defined in ASTM F1292 but not more than depth indicated; maintain top elevation flush with adjacent grades.
      2. Certification: Provide IPEMA certification of ASTM F1292 Critical Fall Height at thickness specified.
      3. Manufacturers:
         c. Sof' Fall; Sof'fall Engineered Wood Fiber: www.sof-fall.com.
         d. Substitutions: See Section 01 60 00 - Product Requirements.
   D. Containment Curbs: Cast-in-place concrete; free of sharp vertical edges, protruding elements, and trip hazards.
      1. Size(s): As indicated on drawings.
2. Minimum Edge Radius: 1/2 inch.

E. Rigid Subbase at Tile Surfacing: PCC as specified by Civil Engineer for walk construction

F. Aggregate Base at Tile Surfacing: 3/4” Minus crushed stone with fines

PART 3 EXECUTION

3.01 EXAMINATION

A. Playground equipment installer will perform playground layout prior to installation of footings; verify correctness of layout before starting this work.

B. Verify that playground equipment installation within playground area are complete.

C. Verify location of underground utilities and facilities in the playground area. Damage to underground utilities and facilities will be repaired at Contractor's expense.

D. Verify that subgrades are at proper elevations and that smooth grading is complete.

E. Verify that proper depth of surfacing is marked on base supports of playground equipment.

3.02 PREPARATION

A. Correct subgrade irregularities to ensure that required depth of protective surfacing can be installed, and subgrade elevation is in accordance with manufacturer's requirements.

B. Cover subgrade with geotextile fabric where noted on drawings and/or as recommended by surfacing manufacturer:
   1. Verify that subgrade is free of ruts or protruding objects.
   2. Lap minimum 4 inches width at seams. Adhere seams in accordance with manufacturer's recommendations.
   3. Install fabric smooth, and free of tensile stresses, folds, or wrinkles.
   4. Protect fabric from clogging, tears, or other damage during surfacing installation.
   5. Repair or replace damaged fabric in accordance with manufacturer's recommendations.

C. Inside Use Zones remove all obstructions that would extend into the resilient protective surfacing.

D. Remove rocks, debris, and other similar items.

E. Install containment curbs with top surface flush with intended elevation of top surface of protective surfacing.

3.03 AGGREGATE BASE

A. Install aggregate base as indicated on drawings. Compact aggregate to maximum 95 percent, in accordance with ASTM D1557.

B. Install with top surface of aggregate base no higher than grades and levels indicated and not more than 1/4 inch lower than grades and levels indicated.

C. Install in true, even plane, sloped to provide positive drainage.

D. Flatness Tolerance: 1/4 inch in 10 feet, maximum.

3.04 PCC BASE

A. Install pcc base as indicated on drawings.

B. Finish concrete with a medium broom finish to improve adhesion to tiles.

3.05 TILE SURFACING

A. Install in accordance with CPSC Pub. No. 325, ASTM 1292, ASTM F1487, ASTM F1951, manufacturer's instructions, and requirements of authorities having jurisdiction.

B. Install proper thickness throughout Use Zone(s).

C. Clean PCC surface of dirt and debris. Confirm surface is fully cured, dry, and ready to accept work.

D. Bond tile to substrate with adhesive recommended by manufacturer.
E. Make cutouts around equipment not more than 3/8 inch in width; remove and refit tile as required to reduce gaps.
F. Fill and seal gaps around equipment with sealant.

3.06 ENGINEERED WOOD FIBER SURFACING
A. Install in accordance with CPSC Pub. No. 325, ASTM F1292, ASTM F1951, ASTM F2075, and ASTM F1487, and requirements of authorities having jurisdiction.
B. Cover subgrade with geotextile fabric:
   1. Lap minimum 4 inches width at seams. Adhere seams in accordance with manufacturer's recommendations.
   2. Install fabric smooth, and free of tensile stresses, folds, or wrinkles.
   3. Protect fabric from clogging, tears, or other damage during surfacing installation.
   4. Repair or replace damaged fabric in accordance with manufacturer's recommendations.
C. Install loose fill to depths indicated, with smooth even surface flush with top of surrounding walk paving.

3.07 FIELD QUALITY CONTROL
A. Obtain the services of the equipment manufacturer's field representative to review the finished installation for compliance with specified requirements and with design criteria to the extent known to the Contractor; submit report of field review.
B. Owner or Owner's representative will inspect playground surfacing after installation to verify that surfacing is of proper type and depth and that playground meets specified design safety and accessibility requirements.
C. Repair or replace rejected work until compliance is achieved.

3.08 CLEANING AND PROTECTION
A. Restore adjacent existing areas that have been damaged from the construction.
B. Clean playground equipment of construction materials, dirt, stains, filings, and blemishes due to shipment or installation. Clean in accordance with manufacturer's instructions, using cleaning agents as recommended by manufacturer.
C. Clean playground area of excess construction materials, debris, and waste.
D. Remove excess and waste material and dispose of off-site in accordance with requirements of authorities having jurisdiction.
E. Protect installed products until Substantial Completion.
F. Replace damaged products before Substantial Completion.

END OF SECTION
SECTION 32 31 16 - WELDED WIRE FENCES AND GATES

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Decorative welded wire fencing, gates, and accessories.

1.02 RELATED SECTIONS
   A. Section 03 30 00 - Concrete

1.03 SYSTEM DESCRIPTION
   A. The manufacturer shall supply a total ornamental welded wire fence system of the style, strength, size, and color defined herein. The system shall include all components as required, and shall be fabricated, coated, and assembled in the United States.

1.04 QUALITY ASSURANCE
   A. The contractor shall provide laborers and supervisors who are familiar with the type of construction involved, and the materials and techniques specified.
   B. Manufacturer of fence system must have ten (10) years of documented experience in manufacturing the products specified in this section.

1.05 REFERENCES
   A. ASTM A525 - Specification for General Requirements for Steel Sheet, Zinc-coated (Galvanized) by the Hot-Dip Process
   B. ASTM A641 – Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
   C. ASTM A185 – Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
   D. ASTM B117 – Practice for Operating Salt Spray (Fog) Apparatus

1.06 SUBMITTALS
   A. Manufacturer’s submittal package shall be provided prior to installation.
   B. Changes in specification may not be made after the bid date.
   C. Samples of assembled materials, components, hardware, accessories, and/or colors, if requested.

1.07 PRODUCT DELIVERY, STORAGE AND HANDLING
   A. Upon receipt, materials should be checked for damage that may have occurred in shipping to the job site.
   B. Each package shall bear the name of the manufacturer.
   C. Store products in manufacturer’s unopened packaging.
   D. Store materials in a secure and dry area to protect against damage, weather, vandalism, and theft.
   E. Transport, handle and store products with care to protect against damage before installation.

1.08 WARRANTY
   A. The entire fence system shall have a written 8 Year Warranty against rust and defects in workmanship and materials. In addition, the finish shall be warranted not to crack, chip, peel, or blister for the same period.

PART 2 – PRODUCTS:

2.01 MANUFACTURER
   A. Fencing System:
2.02 MATERIALS
   A. Structural Components: All posts and rails used in the fence system shall be manufactured from coil steel having a minimum yield strength of 55,000 psi. The steel shall be galvanized to meet the requirements of ASTM A525 with a zinc coating weight of 0.60-1.0 ounces per square foot.
   B. Infill: Section infill wires shall be steel with a minimum yield strength of 50,000 psi. The steel shall be galvanized to meet the designation of “regular coating” in accordance with requirements of ASTM A641.

2.03 FINISH
   A. Pretreatment: A five stage non-chrome pretreatment shall be applied. The final stage shall be a dry-in-place activator which produces a uniform chemical conversion coating for superior adhesion.
   B. Coating: Fence materials shall be coated with a TGIC polyester powder-coat finish system. Epoxy powder coatings, baked enamel or acrylic paint finishes are not acceptable. The finish shall have a cured film thickness of at least 2.0 mils.
   C. Color: Black.
   D. Tests: The cured finish shall meet the following requirements:
      1. Humidity resistance of 1,000 hours using ASTM D2247.
      2. Salt-spray resistance of 1,000 hours using ASTM B117.
      3. Outdoor weathering shall show no adhesion loss, checking or crazing, with only slight fade and chalk when exposed for 3 years in Florida facing south at a 45 degree angle.

2.04 FABRICATION
   A. Nominal fence height shall be 60 inches.
   B. Fence Sections shall be manufactured with 1” square x 18 gauge (.049”) tubing welded every 12” to the top and bottom of welded wire panels. Welded wire panels shall be comprised of 6 (.192”) gauge (Washburn & Moen Standard) vertical wires and 6 (.192”) gauge horizontal wires. 4 gauge vertical wires shall be placed 3½” on center. 6 gauge vertical wires shall be placed 1¾” on center. Horizontal wires shall be 6 gauge and spaced to provide style differences but no further apart than would allow substantial rigidity of vertical wires. Horizontal and vertical wires shall be assembled by automatic machines or other suitable mechanical means that will ensure accurate spacing and alignment of all members of the finished fabric. The wires shall be connected at every intersection by electric resistance welding in accordance with all requirements in ASTM A185. Sections shall be capable of supporting a 550 lb. load applied vertically at midspan and a concentrated load of 225 lbs. applied horizontally at midspan without permanent deformation.
   C. Posts shall be 2” square x 11 (.125”) gauge steel tubing. Posts shall be spaced 70” apart from inside face to inside face. Steel rail ends shall be screwed to terminal posts to receive the 1” square top and bottom rails. The rails shall be secured to the rail ends by stainless steel screws. Steel caps shall be provided with all posts.
   D. Heavy duty grade gate frames shall consist of 2” square x .125” wall gate uprights and 1.5” x 1.5” x .125” U-channels for top and bottom members welded at each connection with a 1” x .125” wall diagonal brace welded into place. Infill of matching Fence Section shall be welded into frame.

PART 3 EXECUTION
3.01 PREPARATION
   A. Verify areas to receive fencing are completed to final grades and elevations.
   B. Ensure property lines and legal boundaries are clearly established.
   C. Remove any surface irregularities which may cause interference with the installation of the fence.
3.02 FENCE INSTALLATION
   A. Install fence in accordance with the manufacturer’s instructions.
   B. Excavate post holes to proper depth to suit local conditions for stability and support of the fence system without disturbing the underlying materials. Excavate deeper as required for adequate support in soft and loose soils.
   C. Set fence posts in concrete footers at 70” spacing from inside of post to inside of post. Note that this fence must be stepped for installations on a slope. It can not follow the grade.
   D. Center and align posts in holes to required depth. Place concrete around posts and tamp for consolidation. After tamping, check alignment of posts, and make necessary corrections before the concrete hardens.
   E. Insert rail ends into horizontal rails and fasten in place to the posts.

3.03 GATE INSTALLATION
   A. Set gate posts plumb and level for gate openings specified in construction drawings.
   B. Install gates to allow full opening without interference after concrete has hardened around gate posts. Adjust hardware for smooth operation.

3.04 ACCESSORIES
   A. Install post caps and other accessories to complete fence.

3.05 CLEANING
   A. Contractor shall clean site of debris and excess materials. Post hole excavations shall be scattered uniformly away from posts.
   B. If necessary, clean fence system with mild household detergent and clean water. Excess concrete must be removed from posts and other fencing material before it hardens.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Preparation of subsoil.
   B. Placing topsoil.
   C. Seeding, mulching and fertilizer.
   D. Maintenance.

1.02 DEFINITIONS

1.03 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Maintenance Data: Include maintenance instructions, cutting method and maximum grass height; types, application frequency, and recommended coverage of fertilizer; and herbicide.

1.04 REGULATORY REQUIREMENTS
   A. Comply with regulatory agencies for fertilizer and herbicide composition.
   B. Provide certificate of compliance from authority having jurisdiction indicating approval of seed mixture.

1.05 DELIVERY, STORAGE, AND HANDLING
   A. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable. Deliver seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.
   B. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

PART 2 PRODUCTS

2.01 SEED MIXTURE
   A. Seed Mixture:
      1. Rhizomatous Tall Fescue (RTF): 100 percent.

2.02 SOIL MATERIALS
   A. Topsoil: Excavated from site to the greatest extent possible and supplemented with the below as necessary.
   B. Topsoil: Fertile, agricultural soil, typical for locality, capable of sustaining vigorous plant growth, taken from drained site; free of subsoil, clay or impurities, plants, weeds and roots; pH value of minimum 5.4 and maximum 7.0.
   C. Compost: Well decomposed, stable, weed free; derived from food, agricultural or industrial residuals, biosolids, yard trimmings, or source-separated or mixed solid waste; with no objectionable odors and not resembling the raw material from which it was made; no substances toxic to plants.
      2. Moisture Content: 35 to 55 percent by weight.
      3. pH: 5.5 to 8.9.
      4. Not more than 1 percent man-made matter and without plastic items more than 1 inches in length.
2.03 ACCESSORIES
A. Mulching Material: Cotton-fiber hydromulch free from weeds, foreign matter detrimental to plant life, and dry. Hay or chopped cornstalks are not acceptable.
B. Fertilizer: As recommended by RTF grass seed supplier, with fifty percent of the elements derived from organic sources, and of proportion necessary to eliminate any deficiencies of supplied topsoil as indicated by soil analysis.
C. Water: Clean, fresh and free of substances or matter that could inhibit vigorous growth of grass.

2.04 TESTS
A. Provide analysis of topsoil fill under provisions of Section 01 40 00.
B. Analyze to ascertain percentage of nitrogen, phosphorus, potash, ________, soluble salt content, organic matter content, and pH value.
C. Submit minimum 10 oz sample of topsoil proposed. Forward sample to approved testing laboratory in sealed containers to prevent contamination.
D. Testing is not required if recent tests are available for imported topsoil. Submit these test results to the testing laboratory for approval. Indicate, by test results, information necessary to determine suitability.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify that prepared soil base is ready to receive the work of this Section.

3.02 PREPARATION
A. Prepare seedbed as detailed in Landscape Architectural drawings, sheet L301.

3.03 FERTILIZING
A. Apply fertilizer in accordance with manufacturer's instructions.
B. Apply after smooth raking of topsoil.
C. Do not apply fertilizer at same time or with same machine as will be used to apply seed.
D. Mix thoroughly into upper 2 inches of topsoil.
E. Lightly water to aid the dissipation of fertilizer.

3.04 SEEDING
A. Apply seed at rate recommended by seed supplier, spreading evenly in two intersecting directions. Rake in lightly.
B. Do not seed areas in excess of that which can be mulched on same day.
C. Planting Season: mid-August through late September.
D. Do not sow immediately following rain, when ground is too dry, or during windy periods.
E. Immediately following seeding, apply mulch to a thickness of 1/8 inches. Maintain clear of shrubs and trees.
F. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches of soil.
G. Following germination, immediately re-seed areas without germinated seeds that are larger than 4 by 4 inches.

3.05 PROTECTION
A. Identify seeded areas with stakes and string around area periphery.
B. Cover seeded slopes where grade is 3 inches per foot or greater with biodegradable erosion control blanket. Roll fabric onto slopes without stretching or pulling.
C. Lay fabric smoothly on surface, bury top end of each section in 6 inch deep excavated topsoil trench. Provide 12 inch overlap of adjacent rolls. Backfill trench and rake smooth, level with adjacent soil.

D. Secure outside edges and overlaps at 36 inch intervals with stakes.

E. Lightly dress slopes with topsoil to ensure close contact between fabric and soil.

F. At sides of ditches, lay fabric laps in direction of water flow. Lap ends and edges minimum 6 inches.

3.06 MAINTENANCE

A. Provide maintenance at no extra cost to Owner; Owner will pay for water.

B. See Section 01 70 00 - Execution Requirements, for additional requirements relating to maintenance service.

C. Provide maintenance of seeded areas for three months from Date of Substantial Completion.

D. Mow grass at regular intervals to maintain at a maximum height of 4 inches. Do not cut more than 1/3 of grass blade at any one mowing.

E. Neatly trim edges and hand clip where necessary.

F. Immediately remove clippings after mowing and trimming.

G. Water to prevent grass and soil from drying out.

H. Roll surface to remove minor depressions or irregularities.

I. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions. Remedy damage resulting from improper use of herbicides.

J. Immediately reseed areas that show bare spots.

K. Protect seeded areas with warning signs during maintenance period.

END OF SECTION
SECTION 32 92 23 - SODDING

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Preparation of subsoil.
   B. Placing topsoil.
   C. Fertilizing.
   D. Sod installation.
   E. Maintenance.

1.02 DEFINITIONS

1.03 REFERENCE STANDARDS
   A. TPI (SPEC) - Guideline Specifications to Turfgrass Sodding; 2006.

1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Certification: Submit certification of grass species and location of sod source.
   C. Maintenance Data: Include maintenance instructions, cutting method and maximum grass height; types, application frequency, and recommended coverage of fertilizer.

1.05 QUALITY ASSURANCE
   A. Sod Producer: Company specializing in sod production and harvesting with minimum five years experience, and certified by the State of Iowa.
   B. Installer Qualifications: Company approved by the sod producer.

1.06 REGULATORY REQUIREMENTS
   A. Comply with regulatory agencies for fertilizer and herbicide composition.
   B. Provide certificate of compliance from authority having jurisdiction indicating approval of fertilizer and herbicide mixture.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Deliver sod in rolls or on pallets. Protect exposed roots from dehydration.
   B. Do not deliver more sod than can be laid within 24 hours.

1.08 MAINTENANCE
   A. See Section 01 70 00 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

PART 2 PRODUCTS

2.01 MATERIALS
   A. Sod: TPI (SPEC), Certified Turfgrass Sod quality; cultivated grass sod; type indicated below; with strong fibrous root system, free of stones, burned or bare spots; containing no more than 5 weeds per 1000 sq ft. Minimum age of 18 months, with root development that will support its own weight without tearing, when suspended vertically by holding the upper two corners.
      1. RTF - Rhizomatous Tall Fescue: 100 percent
   B. Topsoil: Excavated from site to the greatest extent possible and supplemented with the below as necessary.
C. Topsoil: Fertile, agricultural soil, typical for locality, capable of sustaining vigorous plant growth, taken from drained site; free of subsoil, clay, or impurities, plants, weeds and roots; pH value of minimum 5.4 and maximum 7.0.

D. Compost: Well decomposed, stable, weed free; derived from food, agricultural or industrial residuals, biosolids, yard trimmings, or source-separated or mixed solid waste; with no objectionable odors and not resembling the raw material from which it was made; no substances toxic to plants.
   2. Moisture Content: 35 to 55 percent by weight.
   3. pH: 5.5 to 8.9.
   4. Not more than 1 percent man-made matter and without plastic items more than 1 inches in length.

E. Fertilizer: As recommended for grass, with fifty percent of the elements derived from organic sources; of proportion necessary to eliminate any deficiencies of topsoil, as indicated by analysis.

F. Water: Clean, fresh and free of substances or matter that could inhibit vigorous growth of grass.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that prepared soil base is ready to receive the work of this section.

3.02 PREPARATION
   A. Prepare seedbed as detailed in Landscape Architectural drawings, sheet L301.

3.03 FERTILIZING
   A. Apply fertilizer in accordance with manufacturer’s instructions.
   B. Apply after smooth raking of topsoil and prior to installation of sod.
   C. Apply fertilizer no more than 48 hours before laying sod.
   D. Mix thoroughly into upper 2 inches of topsoil.
   E. Lightly water to aid the dissipation of fertilizer.

3.04 LAYING SOD
   A. Moisten prepared surface immediately prior to laying sod.
   B. Lay sod within 24 hours after harvesting to prevent deterioration.
   C. Lay sod smooth and tight with no open joints visible, and no overlapping; stagger end joints 12 inches minimum. Do not stretch or overlap sod pieces.
   D. Where sod is placed adjacent to hard surfaces, such as curbs, pavements, etc., place top elevation of sod 1/2 inch below top of hard surface.
   E. Water sodded areas immediately after installation. Saturate sod to 4 inches of soil.
   F. After sod and soil have dried, roll sodded areas to ensure good bond between sod and soil and to remove minor depressions and irregularities.

3.05 MAINTENANCE
   A. Provide maintenance at no extra cost to Owner; Owner will pay for water.
   B. Provide maintenance of sodded areas for three months from Date of Substantial Completion.
   C. Mow grass at regular intervals to maintain at a maximum height of 3.5 inches. Do not cut more than 1/3 of grass blade at any one mowing.
   D. Neatly trim edges and hand clip where necessary.
   E. Immediately remove clippings after mowing and trimming.
   F. Water to prevent grass and soil from drying out.
G. Roll surface to remove irregularities.
H. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions. Remedy damage resulting from improper use of herbicides.
I. Immediately replace sod to areas that show deterioration or bare spots.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Preparation of subsoil.
   B. Topsoil.
   C. Compost top-dressing.
   D. New trees and plants.
   E. Mulch and Fertilizer.
   F. Accessories
   G. Maintenance.
   H. Tree Pruning.

1.02 DEFINITIONS
   B. Plants: Living trees, plants, and ground cover specified in this Section, and described in ANSI Z60.1.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Submit list of plant life sources.

1.05 QUALITY ASSURANCE
   A. Nursery Qualifications: Company specializing in growing and cultivating the plants with a minimum of 5 years documented experience.
   B. Installer Qualifications: Company specializing in installing and planting the plants with a minimum of 5 years experience.
   C. Tree Pruner Qualifications: Company specializing in pruning trees with proof of Arborist Certification.
   D. Maintenance Services: Performed by installer.

1.06 REGULATORY REQUIREMENTS
   A. Comply with regulatory agencies for fertilizer and herbicide composition.
   B. Provide certificate of compliance from authority having jurisdiction indicating approval of plants, fertilizer and herbicide mixture.
   C. Plant Materials: Certified by federal department of agriculture; free of disease or hazardous insects.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.
   B. Protect and maintain plant life until planted.
   C. Deliver plant life materials immediately prior to placement. Keep plants moist.
1.08 FIELD CONDITIONS
   A. Do not install plant life when ambient temperatures may drop below 35 degrees F or rise above 90 degrees F.
   B. Do not install plant life when wind velocity exceeds 30 mph.

1.09 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Provide one year warranty.
   C. Warranty: Include coverage for one continuous growing season; replace dead or unhealthy plants.
   D. Replacements: Plants of same size and species as specified, planted in the next growing season, with a new warranty commencing on date of replacement.

PART 2 PRODUCTS

2.01 PLANTS
   A. Plants: Species and size identified in plant schedule, grown in climatic conditions similar to those in locality of the work.

2.02 SOIL MATERIALS
   A. Topsoil: Excavated from site to the greatest extent possible and supplemented with the below as necessary.
   B. Topsoil: Fertile, agricultural soil, typical for locality, capable of sustaining vigorous plant growth, taken from drained site; free of subsoil, clay or impurities, plants, weeds and roots; minimum pH value of 5.4 and maximum 7.0.
   C. Compost: Well decomposed, stable, weed free; derived from food, agricultural or industrial residuals, biosolids, yard trimmings, or source-separated or mixed solid waste; with no objectionable odors and not resembling the raw material from which it was made; no substances toxic to plants.
      2. Moisture Content: 35 to 55 percent by weight.
      3. pH: 5.5 to 8.9.
      4. Not more than 1 percent man-made matter and without plastic items more than 2 inches in length.

2.03 SOIL AMENDMENT MATERIALS
   A. Fertilizer: Containing fifty percent of the elements derived from organic sources; of proportion necessary to eliminate any deficiencies of topsoil, as indicated in analysis.
   B. Water: Clean, fresh, and free of substances or matter that could inhibit vigorous growth of plants.
   C. Herbicide: As required.
   D. Pesticide: As required.

2.04 MULCH MATERIALS
   A. Organic Mulch: Shredded Cedar Mulch
   B. Stone Mulch: Use only one of the below for the entire project
      1. Option A: ‘Slatescape’ Stone from Quint City Stone Center; Davenport, IA 563-386-2354
      2. Option B: ‘Midnight Blue’ Granite Landscape Stone from Kafka Granite; Mosinee, WI 800-852-7415

2.05 ACCESSORIES
   A. Below-Grade Tree Stabilizing System, similar or equal to:
B. Weed Barrier Fabric: 5 oz., woven, needlepunched, polypropylene fabric with ground anchoring pins. Limit use to areas described in landscape details.
C. Steel Landscape Edging: 3/16” thickness x 4” height with manufacturer’s steel stakes, powdercoat painted black.

2.06 SOURCE QUALITY CONTROL
A. Provide testing of imported topsoil.
B. Analyze to ascertain percentage of nitrogen, phosphorus, potash, soluble salt and organic matter; and pH value________.
C. Testing is not required if recent tests are available for imported topsoil. Submit these test results to the testing laboratory for approval. Indicate, by test results, information necessary to determine suitability.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify that prepared subsoil is ready to receive work.
B. Saturate soil with water to test drainage.
C. Verify that required underground utilities are available, in proper location, and ready for use.

3.02 PREPARATION OF SUBSOIL
A. Prepare subsoil to eliminate uneven areas. Maintain profiles and contours. Make changes in grade gradual. Blend slopes into level areas.
B. Remove foreign materials, weeds and undesirable plants and their roots. Remove contaminated subsoil.
C. Scarify subsoil to a depth of 4 inches where plants are to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted subsoil.

3.03 PLACING TOPSOIL AND COMPOST
A. Spread topsoil to a minimum depth of 12 inches over area to be planted. Rake smooth.
B. Place topsoil during dry weather and on dry unfrozen subgrade.
C. Remove vegetable matter and foreign non-organic material from topsoil while spreading.
D. Grade topsoil to eliminate rough, low or soft areas, and to ensure positive drainage.
E. Top dress topsoil with 1 inch of compost.
F. Mix compost into topsoil to a depth of 6 inches.
G. Rake and smooth soils to 3 inches below finish grade to allow for placement of mulch.

3.04 FERTILIZING
A. Apply fertilizer in accordance with manufacturer’s instructions.
B. Apply after initial raking of topsoil.
C. Mix thoroughly into upper 2 inches of topsoil.
D. Lightly water to aid the dissipation of fertilizer.

3.05 PLANTING
A. Set plants vertical.
B. Remove non-biodegradable root containers.
C. Set plants in pits or beds as shown on plans. Remove containers, burlap, ropes, and wires from root ball.
D. Saturate soil with water when the pit or bed is half full of topsoil and again when full.

3.06 TREE PRUNING
A. Perform pruning of trees as recommended in ANSI A300.
B. Prune newly planted trees as required to remove dead, broken, and split branches.

3.07 MAINTENANCE

A. Provide maintenance at no extra cost to Owner; Owner will pay for water.
B. See Section 01 70 00 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
C. Maintain plant life immediately after placement. Continue maintenance until installation is reviewed and accepted as Final by Architect and Owner.
D. Irrigate sufficiently to saturate root system and prevent soil from drying out.
E. Cultivate and weed plant beds and tree pits.
F. Remove dead or broken branches and treat pruned areas or other wounds.
G. Neatly trim plants where necessary.
H. Immediately remove clippings after trimming.
I. Control growth of weeds. Apply herbicides only as necessary and in accordance with manufacturer's instructions.
J. Control insect damage and disease. Apply pesticides only as necessary and in accordance with manufacturers instructions.
K. Remedy damage from use of herbicides and pesticides.
L. Replace mulch when deteriorated.

END OF SECTION
SECTION 33 11 16 – SITE WATER UTILITY DISTRIBUTION PIPING

(Specification Section is from the Cedar Rapids Metropolitan Area Standard Specifications for Public Improvements – SECTION 02500 – WATER MAINS)

PART 1 GENERAL

1.01 - Section Includes

A. Water Mains.
B. Water Services.
C. Bolts and Fittings.
D. Valves and Valve Boxes.
E. Fire Hydrant Assemblies.
F. Blowoff Assemblies.
G. Air Release Assemblies.

1.02 - Description Of Work

A. Water Mains – This item includes furnishing and installing water pipe in accordance with the Contract Documents.
B. Water Services – This item includes furnishing and installing water services, and constructing a water service tap (per jurisdictional requirements for City-made tap, see paragraph 3.09.F) on an existing water main which does not have an existing service connection in the required location, in accordance with the Contract Documents.
C. Bolts and Fittings – This item includes furnishing and installing bolts and fittings in accordance with the Contract Documents.
D. Valves and Valve Boxes – This item includes furnishing and installing valves and valve boxes, including gate valves, butterfly valves, and tapping valves and sleeves, in accordance with the Contract Documents.
E. Fire Hydrant Assemblies – This item includes furnishing and installing fire hydrant assemblies in accordance with the Contract Documents.
F. Blowoff Assemblies – This item includes furnishing and installing blowoff assemblies associated with a water main, in accordance with the Contract Documents.
G. Air Release Assemblies – This item includes furnishing and installing air release assemblies associated with a water main, in accordance with the Contract Documents.

1.03 - Submittals

A. Submit test results as set forth in the Contract Documents.
B. Submit certificate of compliance indicating the materials incorporated into the Work comply with the Contract Documents.
C. The substitution of materials is allowed as set forth in General Conditions.
D. Submit joint restraint system.
1.04 - Delivery, Storage And Handling

A. Store material in accordance with the manufacturers’ recommendations and in locations that will minimize the interference with operations, minimize environmental damage, and protect adjacent areas from flooding, runoff and sediment disposition.

1.05 - Scheduling And Conflicts

A. Schedule Work to minimize disruption of public streets and facilities.

B. Discontinue Work that will be affected by any conflicts discovered or any changes needed to accommodate unknown or changed conditions and notify the Engineer.

1.06 - Special Requirements

A. The use of explosives is not permitted unless provided for in the special provisions of the Contract Documents.

B. All work under this section shall be performed by a plumber or pipe layer licensed by the Metro Plumbing Licensing Board. Licensing may be obtained at the Cedar Rapids Code Enforcement Department for all metropolitan area jurisdictions.

C. Unless noted otherwise in the Contract Documents, all materials are to be furnished and installed by the Contractor. Refer to Jurisdictional Special Provisions for exceptions.

D. Unless noted otherwise in the Contract Documents, all labor & equipment is to be furnished by the Contractor. Refer to Jurisdictional Special Provisions for exceptions.

PART 2 PRODUCTS

2.01 - Water Mains

A. Ductile Iron Pipe

1. Minimum thickness class
   a. 4-inch through 12-inch: Class 52 per ANSI/AWWA C151/A21.51.
   b. 16-inch through 20-inch: Pressure Class 250 per ANSI/AWWA C151/A21.51.
   c. 24-inch: Pressure Class 200 per ANSI/AWWA C151/A21.51.
   d. 30-inch through 48-inch: Pressure Class 150 per ANSI/AWWA C151/A21.51.
   e. Special Provisions – See Appendix A.

2. Cement-mortar lined, per ANSI/AWWA C104/A21.4 with asphaltic seal coat.


4. Joint Type: Use push-on type, except where specifically authorized by Engineer.
   b. Mechanical: per ANSI/AWWA C111/A21.11.
   c. Restrained, buried: Pipe manufacturer’s standard field removable system.
   d. Restrained, in structures: Restraining gland, flanged or grooved.
   e. Flanged: ANSI/AWWA C111/A21.11.

g. Gaskets: Per ANSI/AWWA C111/A21.11.

5. Markings on pipe: Name of manufacturer; size and class; and spigot insertion depth gauge.

2.02 - Water Services

A. Refer also to approved service pipe table, in Appendix B of this section.

B. Controlling standards: Local water service, plumbing and fire codes.

C. Materials

1. Ductile Iron Pipe: As specified in Section 2.01. Polyethylene wrap is required.

2. Copper Pipe: Conform to ASTM B88. Wall Thickness: Type K

D. Corporation stop: 1-inch minimum. Stop inlet with AWWA threads. Manufacturer as listed in appendix B or approved equal.

E. Curb stop: 1-inch minimum ball valve. Valve size same as service size. Quarter-turn check. Manufacturer as listed in appendix B or approved equal.

F. Curb box.

1. 1-inch diameter upper half. Stem arch pattern. Height adjustable from 5 ft to 6 ft.

2. Manufacturer: as listed in Appendix B.

3. Special Provisions – See Appendix A.

G. Tapping Saddle.

1. Ductile iron bodies with fusion bonded epoxy coating.

2. Double stainless steel straps with Buna-N gasket seal.

3. Manufacturer: as listed in Appendix B or approved equal.

2.03 - Bolts For Water Main Pipe And Fittings

Corrosion resistant high strength, low alloy steel in accordance with ANSI/AWWA C111/A21.11 (Current Version).

2.04 - Fittings

A. For Ductile Iron Pipe

1. Fittings shall comply with ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21.53.

2. Joint Type: Mechanical or restrained, as required by Engineer.

3. Cement-mortar lined per ANSI/AWWA C104/A21.4 with asphaltic coating or unlined with fusion bonded epoxy per AWWA C116.

4. Restrained Joints

a. Restrained Mechanical Joints: Pipe manufacturer's standard field-removable system.

b. Flanged: ANSI/AWWA C110/A21.10. Nuts shall conform to ASTM A 563, Grade A, heavy
hex head. Gaskets shall be rubber or approved composition; 0.125-inch thick; full face.

c. Grooved: ANSI/AWWA C606. Face to face dimensions shall be equivalent to flanged, ANSI/AWWA C110/A21.10.

7. Fittings shall be smooth and pit free. Coatings shall be uniform and undamaged.

B. For Polyvinyl Chloride (PVC) Pipe use only ductile iron mechanical joint fittings as specified elsewhere in this section.

2.05 - Special Fittings

A. Flange Adapter
   1. Use where noted on Drawings to allow for ease of dismantling piping in the future.
   2. Model: Style 127 as manufactured by Dresser Manufacturing Division, Bradford, Pennsylvania; 912 as manufactured by Smith-Blair.

B. Ductile Iron Sleeve.
   1. Use on buried piping to allow for dismantling piping in future or for connecting two buried plain end pipes.
   2. Long body sleeves are required.

C. Restrained Joints.
   1. Use to restrain mechanical joint where required by Engineer.
   2. Manufacturer: Ebaa Iron, Inc.; Megalug; One Bolt, Oxford, AL; Romac “Grip Ring.”
   3. Substitutions: Pipe manufacturer’s standard field removable restraint system.
   4. Suitable for buried service.
   5. Corrosion resistant components.
   7. Joint restraint system to be field installable, field removable and reinstallable.
   8. Restraint systems involving pipe clamps and connecting rods are not acceptable unless specifically required in the Contract Documents.
   9. Joint restraint system approval; in writing from Engineer.
   10. Contract Documents shall identify locations and number of joints to be restrained.

D. Couplings
   1. Use to join two spigot ends of two pieces of pipe
2. Ductile Iron couplings are to be used for joining pipe sizes up to and including 12-inch.
3. Carbon Steel couplings are to be used for joining pipes greater than 12-inch. Minimum laying length shall be 14 inches. Minimum yield strength of 30,000 psi.
4. Bodies of all couplings are to be Epoxy Coated inside and outside per AWWA C213
5. All bolts, nuts, and hardware are to be grade 304 stainless steel or better.

2.06 - Concrete thrust blocks

A. Application:
   1. For use with pipe sizes up to 16 inch diameter unless approved by Engineer.
   2. For pipe sizes greater than 16-inch diameter, use restraining glands or manufacturers standard restraint system per Paragraph 2.04.

B. Refer to detailed Drawings for dimensions and installation of thrust blocks.

C. Concrete minimum compressive strength is 3000 psi.

2.07 - Pipe Line Accessories


B. Tracer System
   1. Use on all ductile iron and PVC pipe.
   2. Tracer Wire: #12 solid single strand copper.
   4. Splice Kit: Buried service wire splice.
   5. Receptacle Post: 1 lb/ft. channel post 4 feet long. UP-1 by Grimco, Inc., or equal.
   6. Terminations: Scotchcast terminating kit or equal.
   7. Splice Bolt: #8F brass split bolt manufactured by Reliable Power Products, Inc. or approved equal.

C. Insulation: Linear low-density polyethylene (LLDPE) suitable for direct burial applications.
   Color blue. Thickness 0.045 inches.

2.08 - Gaskets, Special

Use special pipe gaskets in contaminated soils if so directed by Engineer. In soils contaminated with gasoline, use nitrile material; for other soil contaminants, use material as required by Engineer.

2.09 - Valves

A. General
   1. Same size as pipeline in which it is installed, unless noted otherwise on Drawings.
   2. Manufacturer’s name or initial and working pressure cast on valve body.
3. Open when turned left or right as required by jurisdiction – See Appendix A. Opening direction arrow shall be cast on operating nut.

4. Factory tested to twice the rated working pressure.

5. Buried service: Mechanical joints, unless noted otherwise.

6. Service within structure: Flanged, per ANSI/AWWA C110/A21.10. Flanges drilled to conform to ASME/ANSI B16.1 class 125, unless noted otherwise. All valve operators to be supplied by valve supplier.

7. Bolts for joints: Refer to paragraph 2.03.A.

B. Butterfly Valves, Buried Service

1. Use: 16-inch diameter and larger

2. Type: Rubber seat.

3. Pressure rating: 150-psi working pressure.

4. Bubble-tight at rated pressures with flow in either direction.

5. Comply with: ANSI/AWWA C504 class 150B.

6. Body: Cast iron per ASTM A 126 class B; two trunnions for shaft bearings.

7. Ends: Mechanical joint, except as otherwise shown in the Plans.

8. Disc: Cast iron ASTM A126 class B, with plasma-applied nickel-chromium edge; connected to shaft by mechanically fixed stainless steel pins.

9. Shaft: Type 304 stainless steel; turned, ground and polished.

10. Seat: Synthetic rubber compound; simultaneously molded in, vulcanized and bonded to body.

11. Bearings: Corrosion resistant and self-lubricating, sleeve type. Bearing load not greater than 1/5 the compressive strength of the bearing or shaft material.

12. Packing: Replaceable Self-Adjusting Packing

13. Operator

   a. Type: Buried service.

   b. 2-inch square nut.

   c. Three bolt minimum mounting to valve.

   d. Hold valve in any intermediate position between fully open and fully closed without creeping or fluttering. Equipped with mechanical stop-limiting devices to prevent over-travel of the disc in the open and closed positions.

   e. Fully enclosed, gasketed and grease packed.

   f. Designed to operate the valve under full rated working pressure with a maximum of 80 foot-pounds applied force. Withstand an input of 450 foot-pounds at extreme operator position without damage.

14. Finish: In accordance with ANSI/AWWA C504; Fusion bonded epoxy per AWWA C550, interior and exterior.
15. Exposed bolts and hex nuts: Per paragraph 2.03 of this section.
16. Approved Manufacturers: DeZurik; Mueller; M&H; Pratt; GA Industries.

C. Gate Valves, Buried Service

1. Type: Non-rising stem, resilient seat. 2-inch square nut operator. Comply with: ANSI/AWWA C509.
2. Pressure rating: 200 psi working pressure up to and including 12-inch and 150 psi over 12-inch.
3. Body, Bonnet and Gate: Cast iron per ASTM A126 class B or Ductile Iron per ASTM A536.
4. Ends: Mechanical joint, except as otherwise noted.
5. Seat, disc rings, stem and spindle: solid bronze bearing against bronze surface.
7. Mechanism design: travel of discs ceases before discs begin to seat in closing; travel of discs commences after disc is fully unseated in opening.
10. Approved Manufacturers: Mueller (Decatur, IL); Clow (Oskaloosa, IA); Kennedy (Elmira, NY); M&H (Anniston, AL).

D. Tapping Valve Assemblies

2. Gasket: To completely surround pipe; minimum thickness 0.125 inch; material: nitrile rubber.
3. Bolts: Per 02500, 2.03
4. Tapping Sleeve (Tap size larger than one-half pipe size).
   a. Cast or ductile iron, full body, split construction.
   b. Must fully surround pipe.
   c. Mechanical joint ends; branch flanged to match tapping valve.
   e. Approved sleeves: American Flow Control, Mueller Company, or approved equal.
   f. Restrictions – See Appendix A. (Cedar Rapids Metro Specifications 2500)
5. Tapping Sleeve (Tap size one-half pipe size or less).
   a. Sleeves shall have fusion bonded epoxy coating per AWWA C213, interior and exterior
   b. Sleeves shall be furnished with type 304 stainless steel bolts and accessories
   c. Smith-Blair Tapping Sleeve 622, Romac FTS 420; Dresser, or equal.

E. Valve Box

1. Applicability: For all buried gate or butterfly valves.
2. Type:
   a. In paved areas (streets, alleys, drives, sidewalks, parking lots), water main less than 12 inches diameter: slide type.
   b. In paved areas (streets, alleys, drives, sidewalks, parking lots), water main 12 inches diameter and larger: slide type with locking lid.
   c. In all other areas; screw extension.
   d. Material: Cast iron. Cast iron cover labeled “WATER”.
   e. Wall thickness: 3/16-inch, minimum.
   f. Inside diameter: 5-inches, minimum.
   g. Length: Adequate to bring top to ground surface.
   h. Factory finish: Asphalt coating.
   i. Manufacturer: East Jordan Iron Works, Tyler, or approved equal.

2.10 - Fire Hydrant
   A. Conform to ANSI/AWWA C502, as modified herein.
   B. Manufacturers and features: See Fire Hydrant Tables, Appendix C of this section. No substitutions unless approved in writing by the Engineer.
   C. Break-away stem coupling.
   D. Painting: Shop coating; per ANSI/AWWA C502. Field coating above grade; exterior coating type and color selection by Engineer.
   E. Provide auxiliary gate valve with valve box conforming to Paragraph 2.08.C. or E.
   F. Exposed bolts and hex nuts: Steel.

2.11 - Blowoff and Air Release Assemblies
   A. Construct according to Detailed Drawings. Locations as shown in plans.
   B. Nominal size: 2 inch
   C. Components: Pipe, valve, curb box, thrust block, elbow, pipe cap and miscellaneous fittings, all as specified or shown. All components shall have iron threads.
   D. Drain-back holes are not acceptable.

PART 3 EXECUTION

3.01 - General Pipe Installation
   A. Property corners are to be placed prior to constructing water main, as required for the Project. If property corners are moved, damaged or disturbed during construction they are to be re-set after construction by a registered Land Surveyor.
   B. Install only approved materials.
   C. Protect pipe joints and valves from damage while handling and storing. Polywrapped pipe is to be handled with lifting straps or other means that protect the wrap from cuts, tears or damage.
   D. Use no deformed, defective, gouged, or otherwise damaged pipe or fittings.
E. Excavate and prepare trench as outlined in Section 31 23 16.13 – Trenching for Site Utilities, Part 3 - Trench Excavation.

F. Prepare the trench bottom with sufficient exactness so that only minor movement of the pipe will be necessary after installation.

G. Clean pipe interior prior to placement in the trench.

H. Install pipe with fittings and valves to the lines and grades shown in the plans, with a maximum allowable variation of 3 inches.

I. Provide uniform bearing along the full length of the pipe barrel. Provide bell holes.

J. Clean joint surfaces thoroughly and apply lubricant approved for use with potable water.

K. Make joints according to pipe manufacturer’s recommendations and these Specifications.

L. Tighten bolts in a joint evenly around the pipe.

M. Install concrete thrust blocks or joint restraints at all bends. Refer to Construction Details.

N. Install remaining pipe bedding in accordance with Construction Details using material conforming to these Specifications.

O. Do not install pipe in water. Keep trench free of water. Refer to ANSI/AWWA C651 for wet trench installation procedures, if Engineer approves such installation.

P. Close ends of installed pipe with water-tight plugs when pipe installation is not underway.

Q. Do not allow any water from the new pipeline to enter existing distribution system piping.

R. Do not locate water service lines under proposed driveway locations and sidewalks.

S. The Contractor shall install water stops in the trench at locations set forth in the Contract Documents. They shall be constructed of clayey excavated material compacted to 95 percent of optimum density (ASTM D698).

T. Water main shall not be installed by directional drilling or horizontal boring without a casing pipe, unless specified otherwise in the Contract Documents.

3.02 - Additional Requirements For Ductile Iron Pipe Installation

A. Install in accordance with AWWA C600.

B. Install with cover per pipe size as follows:

<table>
<thead>
<tr>
<th>Size</th>
<th>Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>10&quot; and smaller</td>
<td>5' 6&quot; cover</td>
</tr>
<tr>
<td>12&quot; to 20&quot;</td>
<td>5' 0&quot; cover</td>
</tr>
<tr>
<td>24&quot; to 30&quot;</td>
<td>4' 6&quot; cover</td>
</tr>
<tr>
<td>36&quot; to 54&quot;</td>
<td>4' 0&quot; cover</td>
</tr>
</tbody>
</table>

C. Cut pipe perpendicular to pipe barrel. Do not damage cement lining. Bevel cut ends for push-on joints according to AWWA C600.

D. Encase pipe, valves and fittings with polyethylene wrap, as required by the respective Jurisdiction.

3.03 - Pipe Insulation
Install where shown or specified. Minimum Thickness: 4 inches.

3.04 - Additional Requirements For PVC Pipe Installation
   A. Cut pipe perpendicular to pipe barrel. B. Install with minimum 5’-6” cover. C. Bevel cut end of pipe barrel per pipe manufacturer’s recommendation.

3.05 - Polyethylene Encasement Installation
   A. Application: All buried ductile iron pipe, fittings, and appurtenances. B. Install in accordance with AWWA C105. C. The polyethylene encasement is to prevent contact between the pipe and the bedding material, but need not be airtight or watertight. Repair all cuts and tears.

3.06 - Tracer System Installation
   A. Install tracer wire on all publicly-owned water mains, privately-owned water mains, and fire service lines into buildings, irrespective of water main material. B. Begin and terminate system at all connections to existing mains. C. Install wire continuously along top center of pipe. Do not install wire along bottom of pipe. Attach wire to pipe at midpoint of each pipe length; use 2-inch wide 10-mil thickness polyethylene pressure-sensitive tape. D. Install splices only as authorized by Engineer. Allow Engineer to inspect all below grade splices of tracer wire prior to backfill. E. Install ground rods at locations shown on plans or as required by Engineer. F. Bring double run of wire to surface at each mainline and hydrant valve location; strip ends of wire and connect together with split bolt. Holes in valve boxes for tracer wire shall be drilled, not sawn. G. Terminate exposed tracer wire at hydrants. Secure to traffic flange with stainless steel straps and hardware. Install the tracer wire and stainless steel straps on property side of hydrant (away from street). H. The Owner will conduct final inspection of the tracer system at the completion of the Project and prior to acceptance. Verify the electrical continuity of the system. Repair any discontinuities. I. Refer to detailed Drawings for tracer wire installation.

3.07 - Transitions in Piping Systems
   Where the specified material of piping system entering or exiting a structure changes, the change shall occur at the outside of the structure wall, beyond any wall pipe or wall fitting required, unless otherwise shown or specified.

3.08 - Structure Penetrations
   A. Wall Pipes
      1. Install where pipes penetrate and terminate at a wall or floor surface of a concrete structure, or where the pipe protrudes through the concrete wall or floor and the protrusion is otherwise unsupported.
      2. Provide a waterstop flange near the center of the embedment length. Waterstop is to be cast integral with the wall pipe, or fully welded to it around the pipe circumference.
B. Wall Sleeves
   1. Install where a pipe passes through a structure wall.
   2. Sleeves in concrete walls are to be supplied with a waterstop collar, fully welded, and shall be cast in place in the concrete.

3.09 - Service Taps and Connections
   A. Provide service tap and connection for each lot or property or as otherwise shown on the plans.
   B. Construct service in conformance with Construction Details.
   C. Consult with Jurisdictional Water Department.
   D. Prepare the Site and make preparatory excavation at the location for the tap. Preparatory Work must be in conformance with Jurisdictional Water Department guidelines and OSHA standards. Blanket main during PVC taps.
   E. Close the tap site in accordance with this Specification and Jurisdictional guidelines.
   F. Coordination – See Appendix A for jurisdiction requirements.
   G. Additional or revised guidelines apply to installations in areas served by Jurisdictions-See Appendix A.

3.10 - Testing
   Test in accordance with Section 01110 of the Cedar Rapids Metropolitan Area Standard Specifications for all public improvements.

3.11 - Flushing
   A. Method of flushing is subject to prior approval of Engineer. Flush in accordance with approved method under the supervision of the Engineer. Refer to Section 01110 of the Cedar Rapids Metropolitan Area Standard Specifications for all public improvements
   B. Disinfection: According to Section 01110 of the Cedar Rapids Metropolitan Area Standard Specifications for all public improvements.

3.12 - General Requirements For Installation Of Valves And Appurtenances
   A. Install only approved materials.
   B. Install in accordance with the Contract Documents, the Construction Details, and the Engineer’s instructions, as appropriate.
   C. Test and disinfect all valves, hydrants and appurtenances as components of the completed water main in accordance with Section 01 45 20 - Site Testing and Inspection Services.
   D. Apply polyethylene wrap to all valves, valve boxes, hydrants and fittings.
   E. Set tops of valve boxes to finish grade in paved areas and 2 inches below finish grade in non-paved areas unless otherwise directed by Engineer.
   F. Check the working order of all valves by opening and closing through entire range.
   G. Support fittings, valves and hydrants on suitable concrete blocks.

3.13 - Flushing Device (Blowoff)
A. Install where shown on the plans, in accordance with Construction Details.
B. Install gravel backfill.
C. Install thrust block, bearing on perpendicular excavation face of undisturbed earth.

3.14 - Fire Hydrant
A. If auxiliary valve is positioned adjacent to water main, attach it to anchoring tee.
B. If auxiliary valve is positioned away from water main, restrain all joints between valve and water main.
C. Fire hydrant depth setting:
   1. Use adjacent finish grade to determine setting depth. If finish grade is not to be obtained during the current Project, consult with Jurisdiction Engineer for proper setting dimension.
   2. Not lower than manufacturer's minimum setting dimension, and not lower than 18 inches, measured from nozzle to grade.
   3. Refer also to Fire Hydrant Tables, Appendix C of this section.
D. Coordinate installation with tracer wire installation.
E. Refer to Construction Details according to Special Provisions in Appendix A.
F. Tee, isolation valve, and associated piping (but NOT barrel) shall be wrapped with polyethylene sheeting.
G. Hydrant extensions will not be allowed. If possible, adjust height by deflection of joints; if necessary, adjust height by use of fittings.

3.15 - Required Separations of Water Mains, Sanitary Sewers, and Storm Sewers
A. Separation of water mains from sanitary sewers and storm sewers shall be in accordance with the Iowa Wastewater Facilities Design Standards, Chapter 12, Section 5.8, “Protection of Water Supplies.”
B. The following factors should be considered in providing adequate separation:
   1. Materials and types of joints for water and sewer pipes.
   2. Soil conditions.
   3. Service and branch connections into the water main and sewer line.
   4. Compensating variations in the horizontal and vertical separations.
   5. Space for repair and alterations of water and sewer pipes.
   6. Off-setting of pipes around manholes.
C. Parallel installation: Water mains shall be laid at least 10 feet horizontally from any existing or proposed sewer or septic tank absorption field trench. The distance shall be measured edge to edge. In cases where it is not practical to maintain a 10-ft separation, the reviewing authority may allow deviation on a case-by-case basis, if supported by data from the design engineer. Such deviation may allow installation of the water main closer to a sewer, provided that the water main is laid in a separate trench or on an undisturbed earth shelf located on one side of the sewer at such an elevation that the bottom of the water main is at least 18 inches above the top of the sewer.
D. Crossings: Water mains crossing sewers shall be laid to provide a minimum vertical distance of 18 inches between the outside of the water main and the outside of the sewer. This shall be the case where the water main is either above or below the sewer with preference to the water main located above the
At crossings, one full length of water pipe shall be located so both joints will be as far from the sewer as possible. Special structural support for the water and sewer pipes may be required.

E. Variance from Iowa Wastewater Design Standard Chapter 12, section 5.8:

1. Water Main Crossing Storm Sewer
   a. Water main ABOVE storm sewer with 6 – 18 inches of separation, OR Water main BELOW storm sewer with 18+ inches of separation.
      Water main shall be constructed of Ductile Iron Pipe (DIP) with Nitrile gaskets, OR Storm sewer shall be constructed of Reinforced Concrete Pipe (RCP) with O-Ring gaskets or water main material of 150 PSI minimum pressure rating.
   b. Water main BELOW storm sewer with 6 – 18 inches of separation.
      Water main shall be constructed of Ductile Iron Pipe (DIP) with Nitrile gaskets, AND Storm sewer shall be constructed of Reinforced Concrete Pipe (RCP) with O-Ring gaskets or water main material with 150 PSI minimum pressure rating.

2. Water Main Crossing Sanitary Sewer
   a. Water main ABOVE sanitary sewer with 6 – 18 inches of separation, OR Water main BELOW sanitary sewer with 18+ inches of separation.
      Water main shall be centrically placed in casting pipe with end seals and supported with casing spacers, OR
      Sanitary sewer shall be constructed of water main material with 150 PSI minimum pressure rating.
   b. Water main BELOW sanitary sewer with 6 – 18 inches of separation.
      Water main shall be centrically placed in casing pipe with end seals and supported with casing spacers, AND
      Sanitary sewer shall be constructed of water main material with 150 PSI minimum pressure rating.

F. Exception: The reviewing authority must specifically approval any variance from the requirements of paragraph C thru E of this section when it is impossible to obtain the specified separation distances.

G. Force mains: There shall be at least a 10-ft horizontal separation between water mains and sanitary sewer force mains. There shall be an 18-inch vertical separation at crossings as required in paragraph D above.

H. Sewer manholes: No water pipe shall pass through or come in contact with any part of a sewer manhole.

3.16 - Service Taps

A. Made at ten o’clock or two o’clock position unless corporation would have less than five feet of cover. When five feet of cover is not available, tap may be rotated downward no farther than midpoint of pipe. Taps shall be no closer than 18 inches apart and staggered around the circumference of pipe.

B. Taps on A-C pipe: purge valve of tapping machines opened so chips will be flushed from pipe.

C. Tapping saddle: See Appendix A for required usage.

D. Wrap service saddle and service line with polyethylene to a point four (4) feet from main toward curb.
3.17 - Water Main Abandonment

A. Water mains must be abandoned in place by using mechanical devices manufactured specifically for such purposes to completely seal the ends of the pipe.

B. Mechanical joint plugs or mechanical joint caps with watertight gaskets must be installed at the termination points of the abandoned water main.

C. Specially fabricated, watertight gaskets are required at the request of the Owner where water main exists in contaminated soil areas.

D. Oversized mechanical joint caps or plugs may be required depending upon the outside diameter of the existing water pipe.

E. The Owner may require the existing water main to be removed from the ground in lieu of abandonment “in place”. Unless such removal is called for on the drawings or in the Special Provisions, a change order to the contract price will be negotiated.

F. Remove valve boxes on valves on abandoned mains to a minimum of one foot below top of grade in unpaved areas, or to bottom of sub-grade in paved areas.

G. Fill remainder of valve box and excavation with sand to a minimum of one foot below grade in unpaved areas, or to bottom of sub-grade in paved areas.

3.18 - Water Service Line Abandonment

A. The Contractor shall disconnect water service at the main. The location of mains, where known, will be provided by the local jurisdiction. The Contractor may be required to schedule excavations in certain streets in accordance with the requirements of the local jurisdiction. Methods of Work on mains and services will be subject to prior approval and inspection by the Engineer. The work shall be subject to approval by the Engineer prior to backfilling.

B. Those water services controlled by a corporation stop on the main shall be disconnected at the main by closing the corporation stop and disconnecting the service line. A cap or corporation nut shall be installed on the corporation stop. Upon completion of a water service disconnect, and inspection of the same, the Contractor shall backfill the excavation. The backfill shall be compacted to 95 percent of the Standard Proctor Density as set forth in ASTM D698.

C. Curb stops and risers must be completely removed from all abandoned service lines. The remaining service line must be terminated in the following fashion:

D. Copper: Install a copper cap using a silver soldering method.

E. Lead: Flatten a minimum of 8 inches of lead pipe end, fold a minimum of 2 inches of flattened end back 180 degrees, then re-flatten forming a folded seal on the tail of the lead service line material.

F. All service lines larger than 2 inch, or manufactured from materials other than copper or lead, must be terminated at a point closest to the water main. Tapping valves shall be removed from its associated tapping sleeves. A blind flange shall be installed on the tapping sleeve, where possible, after the tapping valve is removed.

G. If a blind flange cannot be installed, then one of the following methods of abandonment must be used at the direction of the Owner:

1. The tapping sleeve must be cut out of the water main and a new spigot piece of water pipe must be inserted in its place.

2. A cast iron split repair sleeve shall be installed on the water main to seal the tapped opening in the pipe.

3. A full body cast iron tapping sleeve with blind flange shall be installed on the water main to seal
the tapped opening in the pipe.

4. Unless one of these approaches is called for on the drawings or in the Special Provisions, a change order to the contract price will be negotiated.

H. Service lines that are terminated at a tee must be sealed by installing a mechanical plug, cap, or flange, at the outlet of the tee. If this method of abandonment is not possible then at the Owner’s direction the tee must be cut out of the water main and a new spigot piece of pipe must be inserted in its place. Unless this approach is called for on the drawings or in the Special Provisions, a change order to the contract price will be negotiated.

END OF SECTION, EXCEPT APPENDIX
SPECIAL REQUIREMENTS

1.01. Materials to be furnished by the City of Cedar Rapids

A. City Contracts: For all projects in which the City enters into a Contract with the Contractor, the Water Division will furnish the following materials:

1. Fire hydrant assemblies including:
   a. Mainline tee, tapping sleeve, or tapping saddle.
   b. Pipe, fittings, and accessories.
   c. Hydrant isolation valve, tapping or MJ, and valve box.
   d. Fire hydrant.

2. Main valves and valve boxes including:
   a. Gate valves.
   b. Butterfly valves.
   c. Tapping valves.
   d. Dead-end plug and blow-off assembly.

B. Developments: For those water mains constructed by a developer and which shall be accepted by the City as part of the City’s public Distribution System, the Water Division will furnish at its direct cost the following materials.

   a. Fire Hydrant with isolation valve
   b. Main line valves
   c. Air Release materials
   d. Blow-Off Materials (except the pipe plug tapped for the 2-inch Blow-Off)

(For Development projects the developer or contractor shall furnish pipe, fittings, couplings, valve boxes and pipe plugs.)

B. Private Mains and Fire Lines: The Water Division will not furnish any materials for private water mains, fire protection lines, or service lines. All materials installed in private systems shall meet the same specifications as for public systems, including Poly-Wrap and tracer wire.

C. The Cedar Rapids Water Division will not sell or loan materials from its pipe and fitting inventory, except
when water service to the public has been interrupted and repair parts are not readily available from other sources. A service charge will be added to the cost of the materials sold to the Contractor out of inventory.

D. Unless specifically noted herein, or elsewhere in the Contract Documents, all material needed to complete the work as specified is to be furnished by the Contractor.

1.02. Equipment and Labor furnished by the City of Cedar Rapids

A. The Water Division will furnish labor and tapping equipment necessary to make taps from 1 inch to 12 inches in diameter that are a part of the City contract as defined in Section 1.01 A.

B. On projects constructed under a private contract, the Water Division shall make taps from 1 inch to 12 inches in diameter. The associated tapping fee shall be paid by the Contractor or Developer, whichever is appropriate.

C. The Water Division will furnish all labor and equipment to operate isolation valves in conjunction with the work.

D. Unless specifically noted herein, or elsewhere in the Contract documents, all equipment and labor needed to complete the work as specified is to be furnished by the Contractor.

2.01. Water Mains

A. Ductile Iron Pipe

4. Joint Type. ADD THE FOLLOWING:
   d. Restrained in Structures - Restraining gland flanged or grooved - Use restrained Joint Pipe within Casing Pipe. ‘Gripper’ type gaskets are not approved for pipe within casing.

2.02. Water Services

F. Curb box. ADD THE FOLLOWING:

3. Minneapolis pattern.

5. 1½-inch upper half.

2.06. Pipe Line Accessories

A. Polyethylene Wrap. ADD THE FOLLOWING:

1. Use polyethylene wrap on all buried ductile iron pipe and fittings, and on copper service lines starting at the main and terminating 3 ft away from main.

2.09. Valves

A. General. ADD THE FOLLOWING:

8. Open when turned right.

D. Tapping Valve Assemblies

4. Tapping Sleeve. ADD THE FOLLOWING:

   e. Approved Sleeves: American Flow Control, Mueller Company, TPS Triple Tap, or approved equal.

   g. Cedar Rapids Water Division will provide tapping valve in accordance with 1.01 above.

   6. On 16-inch or larger water mains use a cast or ductile iron full body Tapping Sleeve as in 4. above.
E. Valve Box. REVISE THE FOLLOWING:
   2. Type
      b. Slide type with locking lid for valve boxes in pavement for mains 16-inch and larger.

2.10. Fire Hydrant

D. Painting. ADD THE FOLLOWING:
   1. Interior: asphaltic coating.
   2. Exterior below grade: asphaltic coating.
   3. Exterior above grade: 9 mil epoxy plus two coats enamel (Club Green color).

3.09. Service Taps and Connections. ADD THE FOLLOWING:

F. Coordination
   1. Water main to be in service and all tests passed prior to ordering taps.
   2. Lot pins to be placed prior to making tap.
   3. Call Engineering (286-5957) at least 24 hours ahead of need for taps for all taps.
   4. Confirming and/or cancellation: Call the day of installation (taps 2 inches and smaller).
   5. To have taps made in morning, call Meter Shop (286-5930) between 7:30 a.m. and 8:00 a.m.
   6. To have taps made in afternoon, call Meter Shop (286-5930) between 11:30 a.m. and noon.
   7. Schedule taps larger than 2 inches with Engineering (286-5957) and Distribution (286-5967) at least 24 hours prior to when tap is needed. To cancel scheduled 2-inch and larger taps, call Distribution (286-5967) by no later than 7:00 a.m. on the day of the scheduled tap.

G. Additional Guidelines
   1. Taps 2 inches and smaller are made by the Meter Shop.
   2. Taps larger than 2 inches and up to 12 inches are made by the Distribution Shop.
   3. Taps larger than 12 inches shall be made by the Contractor after notification to the Water Department.
   4. For taps larger than 12 inches, notify Distribution (286-5967) at least 24 hours in advance of commencement of work. Taps are not allowed without authorized City Staff on site.
   5. Contractor shall furnish and install all pipe fittings, and appurtenances, except the mainline tapping valves and valve boxes.

3.14. Fire Hydrant

E. Construction Details. ADD THE FOLLOWING:
   1. Detail 2500-039: Hydrant Set Detail Type I, End of Water Main
   2. Detail 2500-040: Hydrant Set Detail Types II, II-TS, II-Marion, Perpendicular to Water Main, Sheets 1 and 2 of 3
   3. Detail 2500-041: Hydrant Set Detail Type III and Type III-TS, Parallel to Water Main, Sheets 1
and 2 of 2

4. Detail 2500-042: Typical Hydrant Set Elevation View

3.16 Service Taps

C. Tapping Sleeves: ADD THE FOLLOWING:

1. Tapping Saddles required for all services taps

END OF CEDAR RAPIDS SPECIAL PROVISIONS FOR SECTION
APPENDIX B

SECTION 33 13 16 – SITE WATER UTILITY DISTRIBUTION PIPING

APPROVED SERVICE LINE MANUFACTURERS AND MODEL NUMBERS

B.01 - Corporation Stop

A. Cedar Rapids approved manufacturers and model numbers:
   1. Mueller H-15000
   2. AY McDonald 74701
   3. Ford F600

B.02 - Curb Stop

A. Cedar Rapids approved manufacturer and model number:
   1. Mueller H-15154 or H-25154
   2. AY McDonald 76104
   3. Ford B22-M

B.03 - Curb Box

A. Cedar Rapids approved manufacturers and model numbers:
   All Lids to be equipped with 1 1/2 inch, cast iron pentagon plug
   1. Mueller H-10302
   2. AY McDonald 5622

B.04 - Tapping Saddles

A. Cedar Rapids approved manufacturers and model numbers:
   1. Smith Blair Model 317
   2. Romac 202N

END OF APPENDIX B
APPENDIX C

SECTION 33 11 66

APPROVED FIRE HYDRANT MANUFACTURERS AND MODEL NUMBERS

B.01 – Acceptable Manufacturers

A. Cedar Rapids approved manufacturers and model numbers (Furnished by CRWD for Public projects):

1. American Flow Control Model B-84-B
2. Clow Medallion
3. Kennedy Guardian
4. Kennedy K-81D
5. Mueller Super Centurion 200
6. Waterous Pacer, 1996 or newer model

B.02 - Hydrant Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Cedar Rapids</th>
<th>Marion</th>
<th>Hiawatha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Valve Size</td>
<td>5¼ inch</td>
<td>5¼ inch</td>
<td>5¼ inch</td>
</tr>
<tr>
<td>Inlet Connection Type</td>
<td>6-inch MJ</td>
<td>6-inch flanged</td>
<td>6-inch MJ</td>
</tr>
<tr>
<td>Direction of Opening</td>
<td>Right</td>
<td>Left</td>
<td>Left</td>
</tr>
<tr>
<td>Pumper Nozzle Size</td>
<td>5 Inch Storz Connection</td>
<td>4½ inch</td>
<td>5 Inch Storz Connection</td>
</tr>
<tr>
<td>Pumper Nozzle Thread</td>
<td>5.562&quot; OD w/ 6 tpi</td>
<td>5.7659&quot; Diameter National Standard Thread</td>
<td>5.7659&quot; Diameter National Standard Thread</td>
</tr>
<tr>
<td>Hose Nozzle Number/Size</td>
<td>2 ea. - 2½ inch</td>
<td>2 ea. - 2½ inch</td>
<td>2 ea. - 2½ inch</td>
</tr>
<tr>
<td>Hose Nozzle Thread</td>
<td>3.065&quot; OD w/ 6 tpi</td>
<td>3.078&quot; OD Male, 3.140&quot; OD</td>
<td>3.0866&quot; OD Male, 3.0366&quot; OD Female 7½ tpi</td>
</tr>
<tr>
<td>Operating Nut</td>
<td>1-inch square</td>
<td>1¼-inch pentagon</td>
<td>1¼-inch pentagon</td>
</tr>
<tr>
<td>Nominal Bury Depth</td>
<td>6'-0&quot;</td>
<td>6'-0&quot;</td>
<td>6'-0&quot;</td>
</tr>
<tr>
<td>Remarks</td>
<td>Storz connection shall have brass metal face, and hard anodized aluminum Storz ramps and lugs. Cap shall have hard anodized Storz ramps and lugs and be connected to the hydrant with 0.125&quot; vinyl coated aircraft cable. Word &quot;OPEN&quot; and arrow to be cast on top. Two coats of fire hydrant red paint. Dry top design with provision for lubricating operating mechanism. Bronze-bronze seat/seat ring. Weather cap for operating nut.</td>
<td>Word &quot;OPEN&quot; and arrow to be cast on top. Two coats of fire hydrant red paint. Dry top design with provision for lubricating operating mechanism. Bronze-bronze seat/seat ring. Weather cap for operating nut.</td>
<td>Word &quot;OPEN&quot; and arrow to be cast on top. Two coats of fire hydrant red paint. Dry top design with provision for lubricating operating mechanism. Bronze-bronze seat/seat ring. Weather cap for operating nut.</td>
</tr>
</tbody>
</table>
SECTION 33 31 11 - SITE SANITARY UTILITY SEWERAGE PIPING

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Sanitary sewerage drainage piping, fittings, and accessories for gravity flow system outside building lines.

B. Connection of building sanitary drainage system to manholes.

1.02 RELATED REQUIREMENTS

A. Section 31 2316 - Excavation: Excavating of trenches.

B. Section 31 2323 - Fill: Bedding and backfilling.

C. Section 03 3000 - Cast-in-Place Concrete: Concrete for cleanout base pad construction.

1.03 DEFINITIONS

A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.04 REFERENCE STANDARDS


1.05 SUBMITTALS

A. See Section 01 3300 - Construction Submittals, for submittal procedures.

B. Product Data: Provide data indicating pipe, pipe accessories, and cleanout manholes.

C. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Project Record Documents:
   1. Record location of pipe runs, connections, catch basins, cleanouts, and invert elevations.
   2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.06 REGULATORY REQUIREMENTS

A. Conform to applicable code for materials and installation of the Work of this section.
1.07 PROJECT CONDITIONS

A. Coordinate the Work with termination of sanitary sewer connection outside building, connection to municipal sewer utility service, and trenching.

B. Coordinate separation of water and sewer pipes:
   1. Vertical separation: 18 inches, minimum.
   2. Horizontal separation between sewer manhole and water pipe: 3 feet, minimum.

PART 2 PRODUCTS

2.01 SANITARY SEWER SERVICES

A. Polyvinyl Chloride Pipe (PVC).
   1. Pipe and fittings shall be SDR 23.5 and shall conform to ASTM D3034 with a minimum pipe stiffness of 153 psi (ASTM D2412).
   2. Pipe shall be homogeneous throughout and free from visible cracks, holes, foreign inclusions or other injurious defects.
   3. The thermoplastic material for pipe and fittings shall be a rigid PVC plastic and shall meet or exceed the requirements of ASTM D1784 for a minimum cell classification of 12454.
   4. All joints shall be made with gasketed bell coupling connections. No leakage shall occur when gasketed pipe joints are tested in accordance with ASTM D3312 and ASTM D3212. Elastomeric seals (gaskets) shall meet the requirements of ASTM F477.
   5. Pipe fittings including cleanout risers shall conform to ASTM D3034.

B. Sanitary Sewer Service Tap
   1. Polyvinyl Chloride Pipe (PVC) Main
      a. Preformed wye or tee service fitting with gasket joints conforming to ASTM D 3034 and ASTM F949.
      b. Preformed saddle wye or saddle tee for service tap conforming to ASTM D 3034 and ASTM F949.
   2. Polyvinyl Chloride Composite Pipe (PVC Truss) Main
      a. Preformed wye or tee service fitting with gasket joints conforming to ASTM D 2680.
      b. Preformed saddle wye or saddle tee for service tap conforming to ASTM D 2680.
   3. Reinforced Concrete Pipe (RCP) Main
      a. Precast reinforced concrete wye or tee service fitting conforming to ASTM C76.
      b. Preformed connector designed for use with reinforced concrete pipe, conforming to ASTM C923 and A167
   4. All saddle wye or saddle tee fittings must provide positive protection against service pipe insertion beyond inside of sewer main pipe wall.

C. Mechanical plugs shall be provided for each service and shall form an airtight seal with the end of the service.
2.02 BEDDING AND COVER MATERIALS

A. Pipe Bedding Material: Bedding Material Aggregate Fill as specified in Section 32 1123.

B. Pipe Cover Material: General Fill as specified in Section 31 2323.

2.03 Sanitary Sewer Manholes

A. Sanitary sewer manholes shall be of a size and depth as set forth in the Contract Documents. Manholes shall be 48 inches in diameter, unless noted otherwise.

B. Sanitary sewer manholes shall be precast and conform to ASTM C478.

C. Sanitary sewer manholes shall include precast integral base sections with preformed inverts, flexible pipe connectors which are water tight, and precast riser, eccentric reducer, and/or flat top sections and grade rings. All flat tops must be able to support the AASHTO H-20 loading. Top of eccentric cone section shall have a 2-inch minimum vertical face.

D. Channels

1. Preformed inverts shall be sloped to drain.

2. Field constructed channels shall be formed of the same size and shape as the pipes to which they connect, shall form a smooth curve through the manhole of longest possible radius and shall receive a smooth, steel trowel finish. The manhole floor, or bench, outside the channels shall be finished smooth and shall slope toward the channel at not less than one inch per foot. Field constructed channels for “straight-through” manholes may be constructed by laying the pipe continuously through the manhole and breaking out the top half after the surrounding concrete has hardened and neatly dressing the edges.

E. Flexible pipe connectors shall meet all material and performance requirements of ASTM C923.

F. All joints between precast sections shall be fitted with a confined, watertight O-ring or profile gasket between the bell and spigot ends in conformance with ASTM C478, ASTM C361, and AWWA C302.

G. Manhole steps shall be required in all precast manholes, and junction boxes with a height from the lowest flow line to the top of rim in excess of 6 feet. They are not required between precast adjusting rings. Steps shall be an approved plastic-coated 10-inch steel step securely anchored into the riser section. The steel step shall be a ½-inch bar, Grade 60, in accordance with ASTM A615. Steps where provided shall be manufactured of polypropylene encased steel, and comply with ASTM C478.

H. The manhole frame and lid shall be of uniform quality and free from defects. Metal used in the manufacture of gray iron castings shall conform to ASTM A48, Class 35, or ASTM A536, Grade 65-45-12 for ductile iron. Minimum weight shall be 300 pounds. If casting is to be anchored to the manhole structure per Contract Documents, provide a minimum of 4 bolts. Bolt diameter shall be as recommended by manhole structure manufacturer. Refer to Appendix A, this section for list of approved castings.

I. The lid shall fit in the frame such that it does not rock. The frame and lid shall be watertight and self-sealing with a compression gasket and a concealed pick hole.

J. External Manhole Chimney Seals, a flexible watertight sleeve connected to the casting frame and to the precast adjusting rings, or to the cone section, shall be subject to approval in advance by the Engineer. The flexible rubber sleeve shall be in conformance with ASTM C923, with a durometer hardness of approximately 45. The unexpanded vertical height of the sleeve shall be a minimum of 9 inches, and minimum thickness of the sleeve shall be 3/16 inch. After installation in the unexpanded position, the sleeve shall be capable of repeated vertical expansions and contractions of at least 2 inches.
1. The top of the rubber sleeve shall be mechanically locked onto the casting with a compression band to form a watertight seal that cannot be broken through repeated expansion and contraction cycles. The bottom of the sleeve shall be fastened securely to the precast concrete adjusting rings, or to the top of the cone section if applicable, with a compression band, to form a watertight seal which cannot be broken or shifted during vertical expansion or contraction of the casting. The sleeve shall be capable of withstanding at least 1-inch lateral movement of the casting without breaking the watertight seal.

2. When the vertical height of precast concrete adjusting rings is such that the bottom of the sleeve cannot form a watertight seal on the cone section, an extension skirt shall be used to cover any exterior portion of the manhole chimney from the bottom of the rubber sleeve down onto the top of the cone section. The extension skirt shall be securely fastened with compression bands at the bottom of the sleeve and on the cone section.

3. The compression band used to fasten the top of the sleeve to the casting, and the compression bands used to fasten the bottom of the sleeve and the skirt to the manhole, shall be a minimum 1-inch width, 16 gauge stainless steel band conforming to ASTM A240, Type 304. Screws, nuts, and bolts used on the band shall be stainless steel conforming to ASTM F593 and F594, Type 304. Fastening methods shall be subject to approval in advance by the Engineer.

4. The extension skirt shall be a minimum 12-oz/sq ft fiberglass-reinforced PVC impervious fabric that is resistant to tears and punctures. Extension skirt material shall be subject to approval in advance by the Engineer. Overlapped skirt sections shall be solvent cement welded and watertight, in a manner provided by the supplier.

5. A bead of butyl rubber caulk, conforming to AASHTO M198, Type B, shall be applied to the concrete manhole surface to help form a watertight seal under the compression bands.

6. Alternative types of seals require approval of the Engineer.

K. Manhole Adjustment Rings (Grade rings)

1. Rings shall be tested to assure compliance with impact and loading requirements per ASSHTO Standard Specification for Highway Bridges.

2. Reinforced concrete manhole rings:
   b. Rings shall be free from cracks, voids, and other defects.
   c. The rings shall contain a minimum of one No. 2 reinforcing rod per 2 inches of ring thickness.
   d. USE NOT ALLOWED IN CEDAR RAPIDS

3. High Density Polyethylene Adjustment Rings
   a. Comply with ASTM D1248 for recycled plastic
b. Test and certify material properties by methods in the following table:

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>TEST METHOD</th>
<th>ACCEPTABLE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melt Flow Index</td>
<td>ASTM D1238</td>
<td>0.3 to 30 g/10 min</td>
</tr>
<tr>
<td>Density</td>
<td>ASTM D792</td>
<td>0.94 to 0.98 g/cm³</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>ASTM D638</td>
<td>2,000 to 5,000 lb/in²</td>
</tr>
</tbody>
</table>

c. Do not use polyethylene grade adjustment rings if exposure to HMA pavement is possible or expected.

d. When a single ring is used, provide tapered adjustment ring that may vary from 1/2-inch to 3-inch thickness.

e. Install adjustment rings on clean, flat surface according to the manufacturer’s recommendations and using an approved butyl rubber sealant/adhesive. Apply sealant to manhole, between adjustment rings, and to casting flange.

f. Manufacturer: Ladtech, Inc. or approved equal.

4. Expanded Polypropylene Adjustment Rings

a. Test and certify compliance with the following:
   1) ASTM D3575 for expanded polypropylene (EPP)
   2) AASHTO H25 and HS25
   3) Minimum finished density of 7.5 PCF
   4) UV stability
   5) Minimum 50-year design life

b. Adhesive/sealant shall be M-1 Structural adhesive/sealing meeting the following:
   1) ASTM C920, Type S, Grade NS, Class 25, uses NT, T, M, G, A and O
   2) Federal Specification TT-S-00230-C, Type II, Class A
   3) US Army Corps of Engineers CRD-C-541, Type II, Class A

c. Adjustment rings may be fabricated with one or more of the following:
   1) Upper and/or lower keyway (tongue-and-groove) for vertical alignment between rings
   2) Uniform or variable thicknesses to allow matching flat or sloping surfaces to within ¼-inch to ½-inch of specified final elevation
   3) Flat top surface to allow casting to bear uniformly
   4) Trench or slot for adhesive on the underside

d. Manufacturer: CRETEX Specialty Projects (PRO-RING) or approved equal

5. Rubber adjustment risers shall be rubber composite with the following properties:
a. Density 1.098 grams per cubic centimeter, tested in accordance with ASTM C642.90.

b. Durometer hardness 75A +/- 10 points (molded surface) and 73A +/- 10 points (interior surface), testing based on ASTM D2240.

c. Tensile strength: 232 psi, tested in accordance with ASTM D412-87.

d. Compression deformation: under 145 psi, 6 +/- 2 percent, testing based on ASTM D575.

e. Freeze and thaw when exposed to deicing chemicals: no loss after 50 cycles, tested in accordance with ASTM C672-91.

f. Weathering: Hardness, compressive strength, tensile strength, elongation retained to 100 percent +/- 5 percent, tested in accordance with ASTM D573-88.

g. Risers to be made in flat or tapered configurations and resistant to rotting, chipping, or breaking.

h. Do not use rubber adjustment risers if manhole casting will be in the wheel path of a paved travel lane. Use is permitted outside paved areas.

i. Manufacturer: Infra Riser by GNR Technologies or approved equal.

6. Inside dimension not less than the bottom inside diameter of the ring casting.

7. Minimum inside diameter of 24 inches.

8. The outside diameter of the rings shall match the outside diameter of the top of the eccentric reducer, or opening in flattop, whichever is applicable.

L. Internal manhole chimney seals used for sealing the joint between the manhole frame and chimney or corbel/cone section, shall consists of the following components:

1. The flexible rubber sleeve shall be extruded from a high grade rubber compound conforming to the applicable requirements of ASTM C-923, with hardness (durometer) of 45 ± 5. The sleeve shall be double pleated with a minimum unexpanded vertical height of 8 inches, a minimum thickness of 3/16 inches and shall be capable of a vertical expansion when installed of not less than 2 inches. The top and bottom section of the sleeve shall contain an integrally formed expansion band recess and multiple sealing fins. Any splice used to fabricate the sleeve shall be hot vulcanized and have a strength such that the sleeve shall withstand a 180 degree bend with no visible separation.

2. The expansion bands used to compress the sleeve against the manhole shall be 16-gauge stainless steel conforming to ASTM A-240, Type 304, with a minimum 1-3/4 inch width. The expansion mechanism shall have the capacity to develop the pressures necessary to make a watertight seal and shall have a minimum adjustment range of 2 diameter inches. Studs and nuts used for this mechanism shall be stainless steel conforming to ASTM F-593 and 594, Type 304.

3. Use only if specified in contact documents or if approved by the Engineer.

M. Molded Shield for Manhole Infiltration Barrier

1. Single molded piece consisting of a flat flange that seats on the top of manhole cone sections or flattops and a cylindrical portion that fits inside adjustment rings (grade rings). Flange inside and outside diameters shall match manhole cone section. Cylinder diameter shall match inside diameter of casting.
2. Molded shields shall be fabricated from medium density polyethylene (MDPE) meeting the following requirements:

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>TEST METHOD</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>ASTM D1248</td>
<td>MDPE</td>
</tr>
<tr>
<td>Melt Index</td>
<td>ASTM D1238</td>
<td>4.5</td>
</tr>
<tr>
<td>Density</td>
<td>ASTM D792</td>
<td>0.938</td>
</tr>
<tr>
<td>Tensile strength at yield, PSI</td>
<td>ASTM D638</td>
<td>2800</td>
</tr>
<tr>
<td>Elongation at break, %</td>
<td>ASTM D638</td>
<td>400</td>
</tr>
<tr>
<td>Flexural Modulus, tangent, PSI</td>
<td>ASTM D790</td>
<td>115,000</td>
</tr>
<tr>
<td>ESCR</td>
<td>ASTM D1693</td>
<td>1,000</td>
</tr>
<tr>
<td>UL-94 @ 0.060 and 0.120 thickness</td>
<td>UL-94</td>
<td>HB</td>
</tr>
<tr>
<td>Deflection Temp., 88 PSI, degrees C</td>
<td>D648</td>
<td>83</td>
</tr>
<tr>
<td>Deflection Temp., 264 PSI, degrees C</td>
<td>D648</td>
<td>42</td>
</tr>
<tr>
<td>Low Temp. Impact, -40 degrees C, Ft-LB</td>
<td>ARM</td>
<td>68</td>
</tr>
<tr>
<td>Proof load test</td>
<td>AASHTO M306</td>
<td>40,000</td>
</tr>
</tbody>
</table>

3. Butyl sealant for attaching molded shields to manhole cone sections shall conform to AASHTO M198.

N. Heat Shrinkable Sleeve for Manhole Infiltration Barrier

1. Heat shrinkable sleeves shall be an irradiated and cross-linked polyethylene impermeable backing, coated with a protective heat-activated adhesive and capable of bonding to primed concrete, metal, or fiberglass surfaces.

2. Properties of Heat-Shrinkable Sleeve

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>TEST METHOD</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peel Strength</td>
<td>ASTM D1000</td>
<td>8.6 LBS/LINEAL INCH</td>
</tr>
<tr>
<td>Lap Shear</td>
<td>ASTM D1002</td>
<td>1.5 LBS/SQ. INCH</td>
</tr>
<tr>
<td>Water Absorption</td>
<td>ASTM D570</td>
<td>0.05% MAXIMUM</td>
</tr>
<tr>
<td>Low Temperature Flexibility</td>
<td>ASTM D2671</td>
<td>- 40 DEGREES F</td>
</tr>
<tr>
<td>Supplied Thickness</td>
<td></td>
<td>101 MILS</td>
</tr>
<tr>
<td>Fully Recovered Thickness</td>
<td></td>
<td>125 MILS</td>
</tr>
<tr>
<td>Shrink Factor</td>
<td></td>
<td>40% MAXIMUM</td>
</tr>
</tbody>
</table>

3. Sleeve adhesive shall have a softening point of 212° F as determined by ASTM E28.

4. Properties of Sleeve Backing

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>TEST METHOD</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile Strength</td>
<td>ASTM D638</td>
<td>2900 LBS/SQ. INCH</td>
</tr>
<tr>
<td>Elongation</td>
<td>ASTM D638</td>
<td>600%</td>
</tr>
<tr>
<td>Hardness</td>
<td>ASTM D2240</td>
<td>SHORE D = 46</td>
</tr>
<tr>
<td>Abrasion Resistance</td>
<td>ASTM D1044</td>
<td>35 MG</td>
</tr>
</tbody>
</table>

5. Primers shall conform to manufacturer’s recommendations and be compatible with concrete, steel, and fiberglass substrates and with sleeve adhesive.

O. Seals for New Pipe Openings in Existing Structures
1. Purpose and Description
   a. Purpose: Seal annular space around new pipe installed in opening cored in existing manhole wall.
   b. Description: Modular mechanical seal consisting of rubber links or rings shaped to continuously fill annular space secured by pressure plates and stainless steel hardware.

2. Material Specifications
   a. Modular Seal (Nitrile rubber, oil resistant)
      
      | Property                    | ASTM Method | Value (minimum) |
      |------------------------------|-------------|-----------------|
      | Hardness (Shore A)          | D2240       | 50 ± 5          |
      | Tensile Strength            | D412        | 1300 PSI        |
      | Elongation                  | D412        | 300%            |
      | Compression Set             | S395        | 45% based on 22 hours @ 212°F (100°C) |
      | Specific gravity            | D297        | 1.15            |
      | Color                       | ---         | Green           |

   b. Pressure Plates (Molded Glass Reinforced Nylon)
      
      | Property                   | ASTM Method | Value (minimum) |
      |------------------------------|-------------|-----------------|
      | IZOD Impact-Notched         | D256        | 2.05 ft-lb/in   |
      | Tensile strength @ yield    | D638        | 20,000 PSI      |
      | Tensile strength @ break    | D638        | 20,250 PSI      |
      | Flexural Strength @ yield   | D790        | 30,750 PSI      |
      | Flexural Modulus            | D790        | 1,124,000 PSI   |
      | Elongation, break           | D638        | 11.07%          |
      | Specific gravity            | D791        | 1.38            |
      | Moisture content            | ---         | 0.18%           |
      | Color                       | ---         | green           |

   c. Hardware (Bolts and Nuts)
      1). Material: ANSI Type 316 Stainless Steel, per ASTM F593.
      2). Tensile strength: 85,000 PSI average

3. Approved Products
   a. Model OS-316 PSI-Thunderline/Link Seal Modular Seal as manufactured by Pipeline Seal and Insulator, Inc.
   b. Pre-approved equal to above

PART 3 EXECUTION

3.01 Sanitary Sewers – General
   A. Sanitary sewer materials shall not be installed until trench excavation and bedding has been completed according to Section 02200.
   B. The Contractor shall furnish and install sanitary sewer materials according to the Contract Documents.
C. The Contractor shall inspect sanitary sewer materials for defects. Do not install damaged or defective materials.

D. The pipe interior, and pipe and manhole joints shall be kept clean during installation and between periods of installations.

E. If bottom of excavation is wet, dewater according to Section 2200.

F. The Contractor shall provide uniform bearing for the full pipe barrel length when installed. This shall be accomplished by excavating holes in the bedding for pipe bells. The pipe shall be supported above the bedding material only if the pipe is being incased in concrete.

G. Manhole section and pipe joints shall be assembled according to the Manufacturer’s instructions and verified by the Contractor.

H. The Contractor is responsible to block or anchor pipe as necessary to prevent joint displacement when using movable trench boxes or shields.

I. Junctions of dissimilar pipe materials require an adapter with stainless steel sleeve over adapter and installation recommended by the pipe manufacturer.

J. The Contractor shall backfill the pipe or structure according to Section 02200 and the Contract Documents.

K. The Contractor shall test the sanitary sewer installation according to Section 01110.

3.02 Sanitary Sewer Gravity Mains

A. Pipe installation shall begin at the lowest point of the reach unless approved by the Engineer.

B. The Contractor shall install waterstops in the trench at the locations set forth in the Standard Details. They shall be constructed of clayey excavated material compacted to 95 percent of optimum density (ASTM D698).

C. Contractor shall cut the pipe at structures and when preformed wye service fittings are to be incorporated into the Work. PVC truss pipe shall be sealed at cut edges as recommended by the manufacturer. This shall not apply to the construction of new service wyes on new mains.

D. Line and Grade

1. Install pipe to line and grade shown on plans. Set field grades to invert of pipes.

2. Notify Engineer immediately if discrepancies or irregularities are discovered in line or grade shown by grade stakes.

3. Make detailed measurements as required to construct Work to line and grade established by line and grade hubs.

4. Laser Beam

a. Set laser equipment to proper line and grade from line and grade hubs. Provide adequate forced air ventilation in pipes to improve laser accuracy.

b. Use a level to check line and grade of laser at 25 foot intervals for first 100 feet and then at 50 foot intervals for each setup.

c. Check line and grade of each pipe length.

5. Check alignment of sewer by flashing light between manholes or between last pipe laid and opening at downstream manhole.

6. Correct misalignment, displacement or otherwise defective pipe by removing, relaying or replacing pipe at Contractor’s expense.

E. Cutting Pipe

1. Pipe shall be cut in a neat and workmanlike manner to provide an even surface, perpendicular to the pipe centerline.

2. All burrs and irregularities shall be removed prior to pipe fitting.

3. Bevel ends of push-on type pipe
F. Jointing
1. The gasket position shall be verified prior to compressing the pipe joint together.
2. Only those solvents, adhesives, and lubricants furnished by the pipe manufacturer shall be permitted.
3. Perform push-on joint installation per manufacturer’s instructions.

G. Tolerances
1. Horizontal and vertical alignment of each pipe length shall not vary from design line and grade by more than 1% of the inside diameter of the pipe, as established by the Engineer. This tolerance in grade will be allowed only if the sewer is designed at a slope sufficient to prevent backfall when its limits are reached. All sewer laid incorrectly, as determined by the Engineer, must be re-laid at the Contractor’s expense. Under no condition will a sewer be accepted when one or more pipe lengths have been installed without “fall”.
2. The completed sewer must be laid so nearly in a perfect line that an ordinary electric lantern held at the center of the sewer at a manhole may be wholly visible to the eye at the level of the sewer center at the next manhole.
3. Pipe invert elevations at manholes shall not deviate by more than 0.04 ft from design elevations.

3.03 Sanitary Sewer Services
A. Installation of new services
1. The pipe installation shall begin at a wye fitting unless approved otherwise by the Engineer.
2. Line and Grade
   a. Horizontal Alignment: Service lines shall be constructed at right angles to the sewer.
   b. Grade: Service lines shall be laid at a minimum uniform grade of 1/8 inch per foot unless otherwise noted on the plans.
   c. Depth: The elevation of the service at the property line or easement line shall be sufficiently deep to provide a minimum grade of 1/8 inch per foot from the existing building sewer, where it exits the building, to the end of the service lead. If a service is to be provided for a vacant lot, the service shall be kept at the lowest possible elevation.
3. Connection Fittings
   a. Location of the connection fitting shall be as shown on the Plans to match an existing service or as required by the Engineer.
   b. 45° or 60° wyes shall be utilized for connection of the service leads to the sanitary sewer.
4. Main Risers: Where the cover is greater than 12 feet at the main, a riser may be placed to bring the service to a reasonable depth to match an existing service.
5. No vertical bends greater than 45° will be permitted for service lines.
6. Horizontal directional changes of greater than 45° will be permitted in service lines, provided a cleanout is provided immediately upstream of the bend.
7. Mechanical plugs, when specified, shall not be installed with a lubricant. Plugs shall be inserted loosely until the back washer seats against the bell hub transition. This shall be held in place and the wingnut tightened until the plug is firmly seated.
8. Pipe “caps”, when specified, shall be solvent welded to the pipe on dead end lines, which shall be cut off at a later date when the line is extended.
9. Service connections in excess of 100 feet in length shall have cleanouts installed at 100-foot intervals, including riser pipe lengths. Cleanouts installed at the ends of a
long pipe run shall allow one-way cleaning, and cleanouts at intermediate points along a long run shall allow cleaning in both directions of the pipe run.

10. Notify Engineer about services that are possibly live (transporting sewage).
Confirm service status with dye testing, sewage testing, tracer and/or video inspection prior to reconnection or abandonment.

B. Sanitary Sewer Service Tap
1. No new connection, repair, replacement, or cutoff work shall be made on any service line at the sanitary sewer main, in the local jurisdiction right-of-way, or in a local jurisdiction easement, without notifying the local jurisdiction for approval, inspection, and recording purposes.
2. No service connection shall be made to a manhole unless approved in writing by the Engineer.
3. If it is necessary to tap a new connection to the sewer main, the following criteria shall be met:
   a. All taps shall be made with an approved pipe-drilling machine or hole saw to make a clean hole.
   b. A prefabricated saddle with stainless steel clamps shall be set over the hole with a rubber gasket or cemented to form a watertight seal.
   c. Saddles shall be attached to PVC with solvent cement and two stainless steel band clamps.
   d. Tap shall not protrude into sewer main.
4. A new tap shall not be made less than 12 inches from a joint, and never directly on top of the main. Care should be taken neither to make the tap larger than necessary nor to damage the main. The Contractor shall be solely liable for repairing the sewer main damaged by construction operations.
5. Service line connections will normally be 4 or 6-inch lines. A 6-inch service line shall only be connected to an 8-inch or larger main with a prefabricated fitting or a manhole. A service line of 6-inch diameter or larger shall require a manhole at the connection.
6. All service lines shall be connected with precast compression gasket joints or approved adapters.
7. The fitting interior and joints shall be clean prior to lowering into trench and kept clean during installation and between periods of installation, (e.g. downtime).
8. The pipe installation for the service line shall begin at the lowest point of the reach unless approved by the Engineer.
9. Sanitary sewer service line cutoffs shall be done according to Section 01400.
10. No connections, replacements, or cutoffs shall be covered or backfilled until inspection and approval have been completed. The Contractor shall notify the Engineer for inspection prior to any backfilling. Work shall be uncovered for inspection at the order of the Engineer, and shall be in full view from above the ditch, prior to backfilling.

3.04 Sanitary Sewer Manholes
A. Top of manhole structure shall be no more than 18 inches below finished grade.
B. The Contractor shall complete each manhole as the Work progresses, including seals and covers. The Contract Documents shall identify where watertight castings are required.
C. Where inverts are provided and no pipe is placed as a part of this Project, the Contractor shall furnish and install a plug to seal the manhole invert. Plug shall be subject to approval by Engineer before installation.
D. When using PVC pipe, manhole-pipe adapters shall be furnished and installed by the Contractor according to the manufacturer’s instructions.

E. Sanitary manhole bases shall include a concrete fillet, sloped at 1 inch per foot minimum to the gutter, with gutters connecting the flow lines of inlet pipes to the flow line of the outlet pipe. Gutters shall be smooth, with no abrupt bends, and shall be rounded to meet the lower hemispheric radius of the inlet and outlet pipes across the manhole base.

F. Contractor shall install shims as needed to provide a tight fit between the manhole cover and receiving frame. The space between the manhole cover and frame shall be no greater than 1/8 inch without shims and manhole cover shall not rock under the weight of traffic.

G. Manhole adjusting ring (grade ring) installation:
   1. For polyethylene grade rings, bed each ring in a 3/16 to 1/4-inch bead of butyl sealant (use a double bead if surface irregularities are present).
   2. For rubber adjusting risers, bed each riser in a urethane-based mastic, in accordance with manufacturer’s directions.
   3. Do not install more than 2 rings, or a total ring stack height more than 12 inches. For greater adjustment, modify barrel riser section(s).

H. Sanitary sewer services may only be connected to manholes if a precast invert is included in the base section, or as otherwise directed by the Engineer.

I. Infiltration barriers shall be installed according to the manufacturer’s instructions.

3.05 Sanitary Sewer Point Repair

A. The pipe repair shall begin at the lowest point of the reach unless approved otherwise by the Engineer.

B. The Contractor shall provide bypass pumping of the area to be repaired unless the Engineer approves the plugging of the existing line at the upstream manhole and storing the sewage in the main until the repair is complete.

C. The Contractor shall remove existing pipe to a usable joint and provide a banded coupler to connect existing pipe to the repaired section. Coupler shall be subject to prior approval by the Engineer.

D. After completing assembly of the repair couplings, all voids under the exposed sewer line shall be completely filled with compacted bedding material.

E. A prefabricated wye or tee fitting shall be installed as necessary to reconnect service lines within the repair area.

F. The Contractor shall sawcut the pipe at structures and when preformed wye service fittings are to be incorporated into the Work. PVC truss pipe shall be sealed at cut edges as recommended by the manufacturer.

G. All pipe cutting shall be accomplished with a saw intended for the Work to provide a neat cut.

3.06 Connection to Existing Sanitary Sewer Manhole

A. The Contractor shall use a core drill to make round, smooth opening in wall of existing manhole in order to make connection in accordance with the Contract Documents.

B. Place new pipe through cored opening and install modular mechanical seal as specified in accordance with manufacturer’s requirements.

C. During extension of a new sewer line from any part of the existing sanitary sewer system, the new sewer shall be plugged with a mechanical plug until acceptance by the Engineer, to prevent inflow of stormwater and debris to the sanitary sewer system.

D. The Contractor shall then shape a flume in the base of the existing manhole using non-shrink grout.
E. The connection shall be allowed to cure for 24 hours before the pipe installation may occur, unless approved otherwise by the Engineer.

3.07 Conflicts
A. Provide temporary support for existing water, gas, telephone, power or other utilities or service that cross the trench.
B. Compact backfill under existing utility crossing as specified in Section 02200 or construct utility line supports where indicated in the Contract Documents or as directed by Engineer.
C. Separate gravity sewers from water mains by horizontal distance of at least 10 feet unless:
   1. Top of sewer is at least 18 inches below bottom of water main.
   2. Sewer is placed in separate trench or in same trench on bench of undisturbed earth with at least 3 feet separation from water main.
D. Use ductile iron pipe or DR-18 PVC pipe as specified for gravity sewers with less than 10 feet horizontal distance and top of sewer less than 18 inches below bottom of water main; maintain at least 2 feet separation.
E. Where gravity sewer crosses over water main or service or where top of sewer is less than 18 inches below bottom of water main or service, the following requirements apply:
   1. The sewer may not be placed closer than 6 inches below a water main or 18 inches above a water main. The separation distance shall be the maximum feasible in all cases.
   2. Use 20-ft length of ductile iron pipe or DR-18 PVC as specified for gravity sewer centered on water main.
   3. The sewer and water main must be adequately supported and have watertight joints.
   4. Backfill trench with low permeability soil for 20-ft length centered on crossing.
F. Separate sanitary sewer force mains from water mains by horizontal distance of at least 10 feet unless:
   1. Force main is constructed of water main materials meeting minimum pressure rating of 200 psi and
   2. Force main is laid at least 4 linear feet from the water main.

3.08 FIELD QUALITY CONTROL
A. Perform field inspection and testing in accordance with Section 01 4000.
B. Visual inspection of pipe: Lamp all pipe to visually inspect for defects and debris. Acceptable pipe.
C. Alignment and Grade: Perform continuous checks using laser; flash light between manholes and between last piece of pipe laid and opening at downstream manhole.
   1. Do not permit striking or excessive pressure applied to pipe to "seat" pipe in final position.
   2. Do not block or shim pipe with wood, stone, or similar materials.
D. Test for leakage and deflection. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to the Owner.

3.09 PROTECTION
A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

END OF SECTION
SECTION 33 41 00 - STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipe and fittings.
2. Nonpressure transition couplings.
3. Pressure pipe couplings.
4. Expansion joints and deflection fittings.
5. Cleanouts.
6. Drains.
7. Stormwater inlets.
8. Stormwater detention structures.

1.3 SUBMITTALS

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

1.4 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
B. Protect pipe, pipe fittings, and seals from dirt and damage.
C. Handle manholes according to manufacturer's written rigging instructions.
D. Handle catch basins and stormwater inlets according to manufacturer's written rigging instructions.

1.5 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 Owner no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Owner's written permission.
PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76.
   1. Joints shall be tongue and groove without o-rings, unless otherwise noted on plans.
   2. Class III, Wall B
   3. Tongue and groove joints shall be wrapped in sections of 18" wide engineering fabric, with 12" overlap between fabric sheets.

B. High Density Polyethylene Pipe (PEP) shall be corrugated with integrally formed smooth interior meeting the requirements of AASHTO M294, Type S and ASTM F667. Depth of cover up to 12' conforming to ASTM C76 or AASHTO M170.

2.2 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 Individual FRP steps; FRP ladder; or ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, 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.
       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. NyloPlast –Traffic and Non-Traffic related
C.  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."

2.3  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 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:  2 percent through manhole.
   2.  Benches:  Concrete, sloped to drain into channel.
      a.  Slope:  8 percent.

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 deformed steel.

2.4  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.

2.5 PIPE OUTLETS

A. Head Walls: Cast-in-place reinforced concrete, with apron and tapered sides.

B. Flared End Sections: (RCP) Reinforced Concrete Pipe: shall conform to ASTM C76, with a strength of Class III and a B Wall. Unless otherwise noted, tongue and groove joints without o-rings. Provide pipe guards. Lift holes will be allowed.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Division 31 Sections.

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 gravity-flow, nonpressure drainage piping according to the following:

   1. Install piping pitched down in direction of flow.

3.3 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 3 inches above finished surface elsewhere unless otherwise indicated.

3.4 STORMWATER INLET AND OUTLET 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.

3.5 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Sections. Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

1. Use warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.6 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 soil tight 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. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.
D. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to OWNER.

3.7 CLEANING

A. Clean interior of piping of dirt and superfluous materials. Flush with water.

END OF SECTION
SECTION 33 46 00 - SUBDRAINAGE

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. Perforated-wall pipe and fittings.
      2. Geotextile filter fabrics.

1.3 SUBMITTALS
   A. Product Data:

PART 2 - PRODUCTS

2.1 PERFORATED-WALL PIPES AND FITTINGS
   A. Perforated PE Pipe and Fittings:
      1. Rigid, type S in accordance with AASHTO M 252 and M-294. Material shall be Advanced Drainage Systems, Inc. N-12 Smooth Interior corrugated polyethylene pipe or approved equivalent (perforated).
      2. Couplings: Manufacturer's standard, band type.

2.2 SOIL MATERIALS
   A. Soil materials are specified in Division 31 Section "Fill."

2.3 GEOTEXTILE FILTER FABRICS
   A. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. when tested according to ASTM D 4491.
   B. Structure Type: Nonwoven, needle-punched continuous filament.
      2. Styles: Flat and sock.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.

B. If subdrainage is required for landscaping, locate and mark existing utilities, underground structures, and aboveground obstructions before beginning installation and avoid disruption and damage of services.

C. Verify that drainage panels installed as part of foundation wall waterproofing is properly positioned to drain into subdrainage system.

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

3.2 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 31 Section "Fill."

3.3 PIPING INSTALLATION

A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.

1. Lay perforated pipe with perforations down.
2. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.

B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.

C. Install thermoplastic piping according to ASTM D 2321.

3.4 PIPE JOINT CONSTRUCTION

A. Join perforated PE pipe and fittings with couplings according to ASTM D 3212 with loose banded, coupled, or push-on joints.

3.5 CONNECTIONS

A. Comply with requirements for piping specified in Division 33 Section "Storm Utility Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

3.6 IDENTIFICATION

A. Arrange for installation of green warning tapes directly over piping. Comply with requirements for underground warning tapes specified in specified in Division 31 Section "Earth Moving."
1. Install PE warning tape or detectable warning tape over ferrous piping.
2. Install detectable warning tape over nonferrous piping and over edges of underground structures.

3.7 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling.
   2. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.

B. Drain piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

D. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to the Owner.

3.8 CLEANING

A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION