VOLUME II OF V

PROJECT MANUAL

FOR

ATLANTA AIRPORT AC HOTEL
COLLEGE PARK, GEORGIA

FOR

CHOICE GATEWAY LLC
56 PERIMETER CENTER EAST
SUITE 450
ATLANTA, GEORGIA 30346

COMMISSION NO. 216014.00

17 OCT 16 - ISSUED FOR CONSTRUCTION
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OWNER
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SUITE 450
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COMMISSION NO.
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SECTION 21 01 00

GENERAL FIRE PROTECTION REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Provide the necessary interface with other Divisions to provide a complete project. Carefully check the Documents of this Division with those Documents of other Divisions. Determine the requirements of any interfacing materials or equipment being furnished and/or installed by those Sections and Divisions, and provide proper installation and required interface.

B. No deviation from the Contract Documents shall be made without the written consent of the Architect and Engineer.

C. All Specifications and Drawings are to be considered together as the Contract Documents. Any work shown in one and not the other, or is implied by either, shall be provided to make a complete project. Should conflicts exist between the Specifications and Drawings or there is an item shown or noted for which is not clearly defined, immediately submit a request for clarification. Under no circumstance will conflicts between the Specifications and Drawings be grounds for additional cost to the Contract after the Contract is established.

D. The Drawings are schematic and are not intended to show the exact location of piping, equipment, etc.

E. Dimensions and information regarding accurate locations of equipment, and structural limitations and finish shall be coordinated and verified with other Divisions of Work. Be prepared to furnish dimensions and information regarding the Work of this Division to other trades.

F. The right is reserved to relocate any sprinkler head a maximum of 10'-0" before it is permanently installed without incurring additional cost to the Contract.

1.02 REFERENCE STANDARDS

A. All work shall comply with the most recently revised versions of all local, state and federal codes, ordinances of the authority having jurisdiction, laws, rules and regulations. Any modifications required by any of the above shall be made without any additional cost to the Owner. Where requirements between governing Codes and Regulations vary, the more restrictive provision shall apply.

B. Nothing contained in the Contract Documents shall be construed as authority or permission to disregard legal requirements and regulations. The Contractor shall thoroughly review the Documents and bring any such conflicts to the attention of the Architect and Engineer prior to Installation.

C. All materials, installation, and workmanship shall comply standards and/or codes of the following:
   2. International Mechanical Code - 2012 edition, with latest Georgia amendments
D. All materials shall be new and shall bear the label of UL.

1.03 DEFINITIONS

A. Provide: to furnish, install and connect.

B. Furnish: to supply all materials, labor, equipment, testing apparatus, controls, tests, accessories and all other items customarily required for the proper and complete application.

C. Install: to join, unite, fasten, link, attach, set-up or connect together, complete, tested, and ready for normal satisfactory operation.

D. Engineer: the Engineer of record.

E. Contract Documents: the complete set of Specifications and Drawings of all Divisions.

F. Work: labor, materials, equipment, accessories, controls and other items required for a complete installation.

G. Concealed: embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces or in enclosures.

H. Exposed: not installed underground or concealed.

I. Equal: equal in quality, workmanship, materials, weight, size, design and efficiency of the specified product, conforming with manufacturers.

J. Supply: to purchase, procure, acquire and deliver complete with related accessories.

K. Authority Having Jurisdiction (AHJ): applicable local, state and federal authorities having jurisdiction over any part of the Scope within this Division and other Divisions.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturer’s names and catalog numbers specified in the Contract Documents are intended to describe the material and set the standard of quality. All bids shall be based on material specified. Request for approval of material not specified shall be considered if the request is in written form and submitted to the Architect no later than fourteen (14) days prior to the bid date. All requests shall conform to the provisions of the general and supplementary conditions.
B. When specific names are not stated, only the best available quality of material or equipment shall be submitted for review and used in the installation.

2.02 BASIS OF DESIGN

A. Where a product is designated as "BASIS OF DESIGN", the Contractor is notified that mechanical, electrical, structural, architectural, space conditions and/or other features of the overall project design have been based on the requirements of the "BASIS OF DESIGN" product.

B. Where a product is substituted for a "BASIS OF DESIGN" product, the Contractor is notified that changes in project design may be mandatory in order to permit use and installation of the substitute product. Shop drawing submittal for a substitute product shall include a complete schedule of changes in project design, if any, which must be made in order to permit use and installation of the substitute product. The Contractor shall bear all expenses related to the use of a substitute product.

2.03 SHOP DRAWINGS AND PRODUCT DATA

Refer to SRSS Section 01 33 00.

2.04 AS-BUILT DRAWINGS

Refer to SRSSA section 01 78 39 - Project Record Documents.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The equipment selections used in the preparation of the Contract Documents will fit into the physical spaces provided and indicated, allowing ample room for access, servicing, removal and replacement of parts, etc. Adequate space shall be allowed for clearance in accordance with the Code requirements and the requirements of the local Authorities having jurisdiction, and the equipment manufacturer's recommendations.

B. In the preparation of Drawings, a reasonable effort to accommodate acceptable equipment manufacturer's space requirements has been made. However, since space requirements and equipment arrangement vary according to each manufacturer, the responsibility for initial access, maintenance access, code required access, and proper fit rests with the Contractor.

C. Physical dimensions and arrangements of equipment to be installed shall be subject to the Architect's and Engineer's review.

D. The General Contractor and all Subcontractors shall coordinate the installation of ductwork, conduit, busway, piping, cable trays, etc., installation with lighting fixtures, special ceiling construction, air distribution equipment, and the structure. Provide additional rises, drops and offsets as required. If after installed, new ductwork, conduit, busway, piping or cable is found to be in conflict with the architecture, structure, or other trade Work which is either existing or shown on the Contract Documents, the ductwork, conduit, busway, piping or cable shall be relocated without additional cost to the Owner.

E. No piping, equipment, etc., shall be installed in the eight (8) inch high zone directly above the ceiling in tenant areas to allow for tenant build-out and flexibility unless otherwise specifically shown on the Drawings or prior written authorization is received from the Engineer.

F. Accessibility and Clearance:
1. Piping, etc. shall be installed in accessible locations, avoiding obstructions, preserving headroom, and keeping openings and passageways clear.

2. Minor adjustments in the locations of equipment shall be made where necessary, providing such adjustments do not adversely affect functioning of the equipment.

G. Scaffolds and staging for installation of fire protection work shall be provided under the work of this Division.

3.02 STRUCTURAL FITTINGS

A. Furnish and install the necessary sleeves, inserts, hangers, anchor bolts, and related structural items. Install at the proper time.

B. Openings may have been indicated on the Architectural and Structural drawings. Should any additional openings or holes be required, the same shall be provided at no additional cost to the Owner.

C. Location: At a time in advance of the work, verify openings shown on the Architectural and Structural drawings, and coordinate any additional openings.

D. If the work of this Section requires modification of the Architectural or Structural drawings, furnish new instructions as to requirements for these openings. Submit for review and coordination to Architect.

E. Sleeves shall be supplied for all piping passing through walls or slabs and shall be placed before concrete is poured.

F. Equipment supports for fire protection work shall be fastened to the structure by inserts, anchor bolts, bolting to drilled and tapped structural members, or be welded to the structure.
   1. Welding shall be done by the electric arc method with fully competent welders. Supporting members shall be shop coated with a suitable primer.
   2. Surfaces damaged by installation of supports shall be touched up with primer to match shop coat. Any drilling of structural members shall be approved by the Architect.

G. Flashing:
   1. Wherever piping passes through the roof or outer walls, base flashing and counter-flashing shall be provided.
   2. Such flashing shall be properly installed by skilled workmen, and shall include grouting, mastic or tar application, or other means to insure a permanent, waterproof, neat and workmanlike installation.
   3. Insofar as possible, flashing shall comply with and be similar to requirements for flashing in General Construction Work.

H. Anchor bolts and inserts shall be galvanized and of adequate size and strength for installation of electrical work and shall be placed in forms before concrete is poured.
   1. Placement of bolts in bases shall be done under other Division. Furnish detail drawings, templates, and anchor bolts for bases to the General Contractor in time to avoid delaying work schedules.
   2. Expansion shields shall only be used with specific approval of the Architect. Wooden or soft metal plugs shall not be used.

I. Cutting and patching:
   1. All additional cutting, patching and reinforcement of construction of building, subject to review by the Architect, shall be performed under this Section.
   2. Refer to appropriate Division for requirements.
3.03  WEATHERPROOF EQUIPMENT

A. Fire protection devices or equipment located in damp, semi-exposed areas shall be weather-resistant. Enclosures shall comply with NEMA Type 3R requirements.

3.04  CLEANING

A. Brush and clean work prior to concealing, painting and acceptance. Perform in stages if directed.

B. Painted exposed work soiled or damaged: Clean and repair to match adjoining work before final acceptance.

C. Remove dust and debris from inside and outside of material and equipment.

3.05  TESTS AND DEMONSTRATIONS

A. All systems shall be tested in the presence of the Owner or an Owner designated representative upon completion of the Work and demonstrates that the installation is in accordance with the Contract Documents.

B. All motors shall be checked and adjusted for correct direction of rotation.

C. Any work found not to be in compliance with the Contract documents shall be repaired or replaced without incurring additional cost to the Contract price.

D. Provide all instruction to the Owner on maintenance and operation of all systems and equipment provided under this Division.

3.06  WARRANTIES

A. The warranty period for all systems, equipment, components, work, etc. shall be no less than one (1) year, unless specified otherwise hereinafter. The warranty shall include parts and labor.

B. The Contractor shall, without cost to the Owner, remedy any defects within a reasonable time to be specified in notice from the Architect. In default thereof, the Owner may have such work done and charge all costs to the Contractor.

C. The start of the Contractor’s warranty period, as defined in the General Conditions, shall commence on the issue of a “Certificate of Substantial Completion”, by the Owner or the Owner's Representative for each item of material, equipment or system.

D. The Subcontractor shall confer with the General Contractor prior to the bid date concerning the project schedule and determine if there is a need to operate any items of equipment or systems for temporary heating and/or cooling or other reasons prior to “Substantial Completion”. All required extended warranty costs for equipment, materials, and systems shall be included in the Subcontractor’s bid.

END OF SECTION 21 01 00
PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. The Conditions of the Contract and applicable requirements of Division 1, “General Requirements”, and Section 21 11 00 “Fire Protection Systems”, govern this Section.

1.02 DESCRIPTION OF WORK

A. Work Included: Provide pipe hangers, supports, and required appurtenances as specified and indicated.

1.03 QUALITY ASSURANCE

A. MSS Standard Compliance: Provide pipe hangers and supports of materials, design, and manufacture which comply with ANSI/MSS SP-58, SP-59, SP-89, and SP-90.

B. Acceptable Manufacturers: The model numbers listed in the Specification establish a level of quality and material. Subject to compliance with requirements, provide products and materials by the following:
   1. Afcon,
   2. Globe Pipe Hanger Products Inc,
   3. PHD Manufacturing Inc
   4. Anvil International
   5. Cooper B-Line

PART 2 – PRODUCTS

2.01 PIPE HANGERS AND SUPPORTS

A. General: Provide pipe hangers and supports as specified. Comply with local codes and standards for pipe and equipment support and anchorage. Pipe supports shall be of material that will prevent electrolytic action.

B. Inserts: Provide Universal Concrete Insert No. 282 for concrete construction.

C. Piping in Multiple Parallel Runs: Provide Power-Strut or Uni-Strut U-bolt pipe clamps or structural channels or angles with U-bolt clamps, supported as trapeze hangers where multiple parallel runs of piping are shown. Select and size members for weights to be carried and span dimensions between supports.

D. Piping 4” and larger pipes in Single Runs: Provide Fig No. 260 clevis hanger rings.

E. Piping 3” and smaller in Single Runs: Provide Fig No. 69 adjustable swivel hanger rings.

F. Hanger Rod: Provide hanger rods of required length. Rod diameters shall be as listed in the following table. Rod diameters may be adjusted after consultation with the Structural
Engineer concerning the building framing system, the method of attachment to the structure and the support rod spacing.

<table>
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<th>Pipe Sizes</th>
<th>Rod Diameter</th>
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<tr>
<td>1” – 4”</td>
<td>3/8”</td>
</tr>
<tr>
<td>6” - 8”</td>
<td>1/2”</td>
</tr>
<tr>
<td>10” – 12”</td>
<td>5/8”</td>
</tr>
</tbody>
</table>

G. Riser Clamps: Provide Figure 261 riser clamps. Riser clamps for copper tube shall be copper-plated.

H. Piping on Roof: Roof mounted pipe supports are discouraged. If roof supports are necessary, installation methods must be approved by the architect, engineer, general contractor, and Roofing Contractor.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Independent Support: Support fire sprinkler and standpipe piping independently of other piping in accordance with NFPA-approved methods and local codes and standards.

B. Provisions for Movement:
   1. Movement: Install hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate the action of expansion joints, expansion loops, expansion bends, and similar units.
   2. Load Distribution: Install hangers and supports so piping live and dead loading stresses from movement will not be transmitted to any pipe or connected equipment. Pipe supports shall properly transmit the weight of the pipe and its contents to the building structure, or to independent posts, piers, or foundations.
   3. Pipe Slopes: Install hangers and supports to provide the indicated pipe slopes so maximum pipe deflections allowed by ANSI B31 are not exceeded.

C. Spacing: Install hangers and supports in piping systems to remove stress from equipment flanges and rotating equipment. Space hangers and supports as shown in the following table. Rod spacing may be adjusted after consultation with the Structural Engineer concerning the building framing system, the method of attachment to the structure and the support rod diameters.

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Maximum Spacing</th>
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<tr>
<td>1” and 1-1/4”</td>
<td>12’</td>
</tr>
<tr>
<td>1-1/2” – 8”</td>
<td>15’</td>
</tr>
<tr>
<td>10” – 12”</td>
<td>Per Structural Engineer</td>
</tr>
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D. Anchors: Install anchors at the proper locations to prevent stresses from exceeding those permitted by ANSI B31 and to prevent the transfer of loading and stresses to connected equipment. Anchors shall include vibration isolation in accordance with the pipe support system specified. Where the piping system is floating, the anchors shall be termed restraints or braces.
   1. Where expansion compensators are indicated, install anchors in accordance with the expansion unit manufacturer’s written instructions, to limit movement of piping and forces to the maximums recommended by the manufacturer of each unit.
   2. Where not otherwise indicated, install anchors at the ends of principal pipe runs and at intermediate points in pipe runs between expansion loops and bends. Make
provisions for preset of anchors as required accommodating both expansion and contraction of piping.

E. Leveling: Adjust hangers and supports and place grout as required under supports to bring piping to proper levels and elevations.

F. Hangers: Refer to Section 23 05 48, “Vibration Isolation”, for additional information and support requirements. Pipe hangers made of wood, wire, or sheet iron shall not be permitted.

G. Riser Supports: Vertical piping shall be secured at sufficiently close intervals to keep the pipe in alignment and carry the weight of the pipe and contents.
   1. Steel pipe shall be supported at the base and at no less than every other story level, but in no case at intervals greater than 25'.

END OF SECTION 21 05 29
SECTION 21 11 00
FIRE PROTECTION SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. The General Provisions, Supplemental General Provisions, section 21 01 00, Division 1 Specifications and Special Provisions apply to all Work specified in this Section.

B. This section describes the basic materials and installation methods for the fire protection system. Comply with other Division 21 sections and drawings as applicable. Refer to other divisions for coordination of work.

C. Furnish and install all components of the fire protection system specified herein, as indicated on the drawings, and as required to provide complete and operating systems.

1.02 DESCRIPTION OF WORK

A. Work Included: Provide a complete fire protection standpipe system and sprinkler system, including pipe, tube fittings, fire and jockey pumps, and appurtenances as indicated, in compliance with these Specifications and as required by local code agencies.

B. Related Work by Others: The following work shall be provided by the Contractor:
   1. The Sprinkler Contractor shall pipe the discharge of the standpipe drain(s) to the exterior of the building or other location approved by the Architect.
   2. The Electrical/Fire Alarm Contractor will provide a complete fire alarm system and will make connections to flow switches and gate supervisory switches from the fire panel.
   3. The Electrical Contractor will make connections to starters and from starters to fire pump and jockey pump. Labeled terminations within the fire protection equipment shall be provided to allow the connection of fire pump operating controls to the fire command station by the Fire Contractor.

C. Applications: Application of the fire protection system shall include, but are not limited to, the systems as listed below:
   1. Supply mains, valves, risers, and drains.
   2. Standard pattern Siamese connections per local Fire Department Regulations.
   3. Fire hose stairway valves.
   5. Fire pump, controllers, and accessories.
   6. Jockey fire pump, controllers, and accessories.
   7. Dry-pipe air compressor and valves
   8. Hydraulically designed sprinkler system.

D. Quality Assurance:
   1. Materials shall be installed in accordance with NFPA 13 and NFPA 14. Valves, fittings, sprinkler heads, and equipment shall be UL listed and FM approved. Fire pumps and jockey pumps shall also be UL listed and Factory Mutual approved.
   2. Hose threads shall conform to local fire department requirements.
   3. Coordination Drawings: The following supplements, and does not replace, the provisions for submittals called for in Section 23 01 00, "Basic Mechanical Requirements", of this Specification.
a. Before starting fabrication or installation of equipment, the Contractor shall submit to Architect, for his consideration, three sets of Shop Drawings noted as reviewed by the ISO for insurance rate making purposes only.

b. After Contract award and prior to releasing any equipment orders for fabrication, six sets of Shop Drawings showing dimensions, weights, performance data, structural details, and physical appearance of fire pump, jockey pump, valves, and controls shall be submitted to the Architect for review and approval.

4. Acceptable Manufacturers: The model numbers listed in the Specifications establish a level of quality and material. The following manufacturers are acceptable subject to compliance with the requirements of these Specifications:

a. Sprinkler Equipment
   1) Viking Corporation
   2) Tyco Fire Protection Products
   3) Victaulic Corporation
   4) Reliable Automatic Sprinkler Company

b. Fire Hose Equipment
   1) Potter Roemer, Inc.
   2) Elkhart Brass Company
   3) Badger Powhatten
   4) Croker

E. Pipe Hangers and Supports: Support fire protection pipe with UL-listed and FM approved hangers and support devices. Provide any special hangers or supports that may be required. The design, selection, spacing, and application of horizontal pipe hangers, supports, restraints, anchors, and guides shall be in accordance with the NFPA 13 and NFPA 14. Support vertical pipes at least every other floor with approved riser clamps.

F. Combination Standpipe System:
   1. Install a dry pipe sprinkler system for sprinkler piping installed outside of the building insulation envelope and in unheated areas such as attics, canopies, garages, and loading docks to provide complete coverage.
   2. Install combination standpipe system in the hotel consisting of risers extended up from the lowest level with 2-1/2” hose valves on each floor in stairwells and a wet pipe sprinkler system to provide complete coverage on each floor. Completely sprinkler the entire building.
   3. Install a sprinkler system in all elevator shafts and spaces housing elevator machinery or controls. All elevator shafts shall be sprinkled from top of shaft and at elevator pit.
   4. System piping shall be hydraulically designed throughout areas in accordance with the rules and regulations of NFPA 13, using design densities of:
      a. Light hazard areas: 0.10 gpm per 1,500 square feet with maximum Sprinkler head spacing of 225 square feet per sprinkler head.
      b. All ordinary hazard areas: 0.20 gpm per 1,500 square feet with maximum sprinkler head spacing of 130 square feet.
   5. Cross main pipe sizes shall be a minimum of 2” diameter for loop systems and 2 1/2” for single main (non-loop) systems. Generally, provide coverage at the rate required by NFPA and applicable state and local codes.
   6. System shall include fire pump sized to meet water pressure and flow requirements, jockey pump, required drain lines, drum drip (for maintenance), test connections, spare heads, tools, fire department inlet connections, water motor alarms, circuit closers, monitor switches, alarm valves, isolation valves and similar items.
   7. Sprinkler heads, valves, alarms, and similar items shall be as manufactured by Viking, Grinnell, or other approved manufacturer. Sprinkler heads shall be plain brass, up-right type in unfinished areas, semi-recessed in guest rooms, semi-recessed in back of house areas and semi-recessed sprinklers in public areas. Material and equipment used in the installation of the sprinkler systems and
standpipes shall be listed and approved by the Underwriters’ Laboratories, Inc., and shall be the latest design of the manufacturer.

G. Valves: Valves shall be UL-listed and FM approved for the pressures at which they are installed.
   1. Check valves shall be swing type with iron body, bronze trim, cast iron disc, bolted cover, and screwed or flanged ends. Check valves in the pump discharge may be spring loaded, quiet type, and shall be UL-listed and FM approved. Swing check valves may be installed in horizontal pipe only.
   2. Gate valves 2” and smaller shall be bronze body, OS&Y, and screwed ends. 150 psig valves shall have bronze trim, single disc, screwed bonnet, and bronze seats. 300 and 400 psig valves shall have bronze wedge disc, union bonnet, and bronze body seat rings.
   3. Gate valves over 2” shall be iron body, OS&Y, bolted bonnet, bronze seats, ANSI 16.1, flanged ends. 150 psig valves shall have double or single disc, and bronze trim. 300 and 400 psig valves shall have wedge disc and brass stem.
   4. Butterfly valves 2” and larger shall be grooved type. Furnish with built-in supervisory switches.
   5. Supervised valves shall include valve tamper switches. Valve tamper switches shall be double-pole single-throw type with cast aluminum housing and tamperproof cover. Switch rating shall be at least 7 amperes at 125/250 volts.

PART 2 - PRODUCTS

2.01 PIPING

A. Pipe: Standpipe and sprinkler piping shall be ASTM A135, Schedule 40 black steel for pipe sizes 2” and smaller. Thin-wall pipe (schedule 10), ASTM A135, may be used for sprinkler piping larger than 2”. All code approvals shall be secured before shop drawing submittal to Architect.

B. Fittings: Fittings shall be cast iron threaded sprinkler fittings ANSI B16.4 or grooved ends fittings joined by grooved couplings Victaulic Firelock or equal or welded fittings, ANSI B16.9. Flanges shall be screwed or welded neck type ANSI B16.5.

2.02 EQUIPMENT

A. Fire Hose Valves (Stairwells and Sprinkler Taps): Provide 2½”angle valves with 2½” x 1½” reducer a 2½” cap and chain for fire department valves in stairwells and elsewhere as required. Where the water pressure at the valve exceeds 175 psig, provide pressure regulating valves to limit the discharge pressure to 175 psig. Valve bodies shall be rated for the available system pressure. Valves for sprinkler taps shall be the same as hose valves, less cap and chain.

B. Fire Department Connection (Siamese): Wall and remote post Siamese fire department connection with chains and caps shall be polished brass or polished chrome. Verify actual material and finish with the Architect. See Civil Plans for actual location of remote mounted fire department connections.

C. Roof Manifold: Provide rough brass roof manifold on the roof above all stairwells that do not access the roof with two 2½” rough brass fire department gate valves with caps and chains.
D. Water Flow Switch: Include water flow switch, with adjustable retard feature in supply pipe to each floor of each riser for remote alarm. Switch shall be double-pole single-throw type and shall be rated at least 7 amperes at 125/250 volts.

E. Sight Flow Connection: Sight flow connection in test lines.

F. Sprinkler Heads: Brass up-right or pendant heads as required with ordinary temperature rating, except in specially designated areas of high-temperature where heads shall be rated per NFPA 13. Heads in public and tenant space shall be semi-recessed, installed at finished ceiling height. Verify color of sprinkler cover plate with Architect. Pendent heads exposed to weather or freezing conditions shall be dry pendant type. Furnish spare heads equal to 1% of total number of heads installed. The heads shall be representative of, and in proportion to, the number of each type and temperature rating of heads installed. Furnish spare head cabinet and wrench for each riser. Locate cabinets as directed by Architect.

G. Dry Pipe Valve: Viking Model C-2 or equal.

H. Accelerator: Viking Model B-1 or equal.

I. Alarm Bell: Viking Model BH-1003, 6", 120 volt AC or equal.

PART 3 - EXECUTION

3.01 INSTALLATION OF PIPING SYSTEMS

A. General: Comply with the requirements of the piping section of this Specification, NFPA 13 and NFPA 14 for installation and testing of piping system and per local code.

1. Piping shall be concealed, except in mechanical equipment rooms, stairwells, or where otherwise required.

2. Grade piping to eliminate traps and pockets. Where air pockets or water traps cannot be avoided, provide hose bibs for drainage.

3. The Sprinkler Contractor shall arrange with the General Contractor to notch or pre-drill the occasional beam in order to maintain the sprinkler mains as high as possible.

4. All required sprinkler heads shall be individually dropped from the main to the ceiling. Provide each drop with a horizontal swing arm type branch run to allow future movement of the head.

5. All sprinkler heads in areas to be finished shall be installed at finished ceiling height only where the ceiling is to be installed at this time such as elevator lobbies and restrooms. In future tenant spaces, install upright heads at a maximum of 100 square feet per sprinkler head, pending development of the areas. Also, in future tenant spaces, a 1” outlet shall be provided with a temporary 1” nipple and 1” x ½” reducer and a temporary sprinkler head. Coordinate locations to ensure sprinkler heads are centered in ceiling tiles.

6. Sprinkler piping shall be installed and coordinated with the duct and other mechanical and electrical services in the ceiling cavities by this Contractor, to provide the clearances for lighting fixtures as required.

7. Sprinkler piping shall be installed so as not to impede access to mechanical, electrical, or plumbing equipment.

8. Refer to Section 21 05 53, "Fire Protection Identification" for painting, nameplates, and labeling requirements. Painting is not part of this contract scope unless otherwise specified within the contract documents.

9. Sprinkler piping shall be flushed to remove excess oils and contaminants that support the growth of microorganisms.

10. Sprinkler systems shall not be drained/flushed on finished surfaces such as sidewalks and parking lots.
11. Install a ½" Weld-o-let with plug in the main sprinkler line, on the down stream side (building side) of the flow switch for introduction of micro biocides by the Owner at a later date.

B. Protection during Construction: Provide necessary fire protection during construction and initial occupancy in accordance with NFPA and Local Codes. Provide active sprinkler systems in areas requiring sprinklers during this period before tenant finish-out. If specifically approved for this Project by the local inspector, this Contractor may install active sprinklers only in areas designated as storage areas, in public areas to be finished with the base building, mechanical spaces, and limited other areas required by the inspector during construction. Coordinate these areas with the General Contractor.

C. Inspections and Tests: All inspections, examinations, and tests required by the authorities and/or agencies specified hereinbefore shall be arranged and paid for by this Contractor, as necessary, to obtain complete and final acceptance of the system as installed. The certificates of inspection shall be in quadruplicate, and shall be delivered to the Architect for distribution.

D. Underground Fire Protection Piping: Material for pipe cushion shall comply with local codes and or the geo-technical report. In absence of local code requirements or geo-technical report, the cushion shall be bank sand or select backfill material approved by the Architect. Any material used shall pass a one-inch screen.

END OF SECTION 21 11 00
SECTION 21 30 00

FIRE PUMPS

PART 1 - GENERAL

1.01 SUMMARY

A. The General Provisions, Supplemental General Provisions, section 21 01 00, Division 1 Specifications and Special Provisions apply to all Work specified in this Section.

B. This section describes the basic materials and installation methods for the fire pump system. Comply with other Division 21 sections and drawings as applicable. Refer to other divisions for coordination of work.

C. Furnish and install all components of the fire pump system specified herein, as indicated on the drawings, and as required to provide complete and operating systems.

1.02 DESCRIPTION OF WORK

A. Work Included: Provide a complete fire protection system, including pipe, tube fittings, fire and jockey pumps, and appurtenances as indicated, in compliance with these Specifications and as required by local code agencies.

B. Related Work by Others: The following work shall be provided by the Contractor:

1. The Electrical Contractor will make connections to starters and from starters to fire pump and jockey pump. Labeled terminations within the fire protection equipment shall be provided to allow the connection of fire pump operating controls to the fire command station by the Fire Contractor.

C. Applications: Application of the fire pump system shall include, but are not limited to, the systems as listed below:

1. Supply mains, valves, risers, and drains.
2. Flow switches.
3. Fire pump, controllers, and accessories.
4. Jockey fire pump, controllers, and accessories.
5. Hydraulically designed sprinkler system.

D. Quality Assurance:

1. Materials shall be installed in accordance with NFPA 13 and NFPA 24. Valves, fittings, sprinkler heads, and equipment shall be UL listed and FM approved. Fire pumps and jockey pumps shall also bear the Factory Mutual (FM) label.

2. Coordination Drawings: The following supplements, and does not replace, the provisions for submittals called for in Section 21 01 00, "General Fire Protection Requirements", of this Specification.

   a. Before starting fabrication or installation of equipment, the Contractor shall submit to Architect, for his consideration, three sets of Shop Drawings noted as reviewed by the ISO for insurance rate making purposes only.

   b. After Contract award and prior to releasing any equipment orders for fabrication, six sets of Shop Drawings showing dimensions, weights, performance data, structural details, and physical appearance of fire pump, jockey pump, valves, and controls shall be submitted to the Architect for review and approval.

E. Fire Pump System:

1. System shall include fire pump (where needed to meet water pressure and flow requirements), jockey pump, required drain lines, test connections, spare heads,
tools, fire department inlet connections, water motor alarms, circuit closers, monitor switches, alarm valves, isolation valves and similar items.

PART 2 - PRODUCTS

2.01 FIRE PUMPS

A. Capacity: Fire pumps shall deliver the design capacity at a suction condition as low as zero psi. This Contractor shall verify local, residual, and expected pressure variations. The pumps shall also deliver not less than 150% of rated capacity at a pressure not less than 65% of rated head. Shutoff pressure shall not exceed 120% of rated pressure.

B. Type: Fire pumps shall be horizontal split case, full ball bearing, grease-lubricated, 2-stage, double suction type.

C. Accessories: Fire pumps and accessories shall meet requirements of National Fire Protection Association (NFPA) No. 20 and shall be UL listed and FM approved. Where FM requirements are more stringent than UL and result in a higher cost, indicate the price added to provide the FM approved equipment.

D. Test Header: Provide wall mounted test header either polished brass or polished chrome. Verify actual material and finish with the Architect.

E. System Head: Pumps, casings, and seals shall be suitable for operation with the system head required by the application.

F. Base Plate and Coupling: Pumps and motors shall be mounted on a common cast iron base plate with drip base connection for drain. Pump coupling shall be flexible coupled.

G. Motor: Pump motors shall be open drip-proof type. Locked rotor current shall not exceed the values specified in NFPA No. 20. Each motor shall be of such capacity that at rated voltage under any pump operating condition, the full load ampere rating shall not be exceeded except as permitted by the service factor stamped on the motor nameplate.

H. Motor Control: Motor control equipment shall be completely assembled, wired, and tested at the factory. The assembly shall be specifically UL and FM-approved for fire pump purposes. Controller shall be marked FIRE PUMP CONTROLLER. Equipment shall be enclosed in one or more approved drip-tight enclosures. Controller shall be of the combined manual and automatic across-the-line type or, if motor is 75 HP or larger, reduced voltage closed transition, star delta type or reduced voltage part-winding type incorporating the following:
   1. Disconnect Switch: Externally operable quick-make quick-break type.
   2. Circuit Breaker: Time delay type with trips in phases set for 300% of motor full-load current. Interrupting capacity of circuit breaker shall be at least 30,000 amperes RMS symmetrical at 480 volts. Verify interrupting capacity with the Electrical Contractor.
   3. Motor Controller: Firetrol or approved equal, UL-listed, with a FVNR, across-the-line, RVNR, wye-delta type, closed transition or RVNR, part-winding starter capable of being energized automatically through the pressure switch or manually by an externally operable handle.
   4. Pressure Switch: Set to sense drop in the system pressure for starting pump.
   5. Running Period Timer: Set to operate motor when started automatically for a minimum running period of one minute for each 10 HP motor rating, but not to exceed 7 minutes.
6. Alarms: Provide UL and FM-listed alarm relays and accessories to provide for the following:
   a. A controller mounted 120 volt alarm bell. Bell shall sound continuously whenever the fire pump is running and shall be energized from the fire pump feeder via a control power transformer.
   b. Alarm relay to indicate a fire pump input power failure or circuit breaker open position. This relay shall energize a remote audible and visual alarm at the Engineer's office (refer to Paragraph 2.08 for alarm panel) and shall be energized from an independent power source.
   c. Contacts and pilot lights in controller to indicate power available and circuit breaker "OPEN" and "CLOSED". Pilot lights shall be energized from an independent power source.
   d. Output contacts to provide fire pump running and input power failure/circuit breaker open inputs to the fire alarm system furnished under Division 16.

7. Control Power: Provide control power transformers with fusing and disconnect switches where required.

8. Test Link and Studs: Ammeter test links and voltmeter test studs.

9. Manual Selection Station: A 2-position push-button marked "START-STOP" and an emergency start handle shall be provided on the enclosure.

10. Miscellaneous: See Division 26, Electrical, for other motor controller requirements.

11. Manual Override: Provisions shall be made to manually override the controls and permit manual operation of fire pump from the Fireman's Control Room.

12. Automatic Transfer Switch: Where required, provide a dedicated, integral automatic transfer switch to transfer from normal to emergency power source in the event of normal power failure. Transfer switch shall comply with the requirements of Division 26 and NFPA 20.

2.02 JOCKEY PUMPS

A. Capacities: Fire jockey pumps shall deliver the capacities listed.

B. Type: Pumps shall be multistage, bronze fitted, bronze impeller, with stainless steel shaft and grease-lubricated ball bearings.

C. Rating: Pumps, casings, flanges, and mechanical seals shall be rated for operation with the working pressures required by the application.

D. Coupling: Pumps shall be flexible coupled.

E. Controls: Fire jockey pumps shall be complete with controls to automatically maintain pressure on the standpipe system to prevent the fire pumps from operating on drops in pressure of 5.0 psig or less. Controller shall be Firetrol FTA 500A-D05B or approved equal. The control panel enclosure shall be NEMA Type 1, wall-mounted, factory-assembled, wired, tested, and shall be finished with a baked enamel coating. Panel shall include at least the following equipment:
   1. 1 – Non-fused disconnect switch mounted on panel door.
   2. 1 - FVNR combination magnetic motor starter with circuit breaker.
   3. 1 - HAND-OFF-AUTOMATIC selector switch mounted on panel door.
   4. 120 volt control power transformer and fused disconnect switch to operate switches and controls in the panel.
   5. Power failure alarm contact with panel-mounted alarm bell and light and contact for connection to a contact for remote annunciation at the Engineer's office.

F. Base: Pumps and motors shall be mounted on a common cast iron base plate with drip base connection for drain.
G. Relief Valve: Where required, the fire jockey pump shall be furnished with a factory-mounted bypass relief valve complete with piping. Relief valve shall be set to relieve at a pressure of 25 psig above design total dynamic head to prevent motor overload and system damage.

H. Motor: Pump motors shall be open drip-proof type with 115% service factor.

PART 3 - EXECUTION

3.01 INSTALLATION OF FIRE PUMPS

A. General: Comply with the requirements of NFPA 13 and NFPA 20 for installation and testing of piping systems and fire pumps.

B. Protection during Construction: Provide necessary fire protection during construction and initial occupancy in accordance with NFPA and Local Codes. Provide active sprinkler systems in areas requiring sprinklers during this period before tenant finish-out. If specifically approved for this Project by the local inspector, this Contractor may install active sprinklers only in areas designated as storage areas, in public areas to be finished with the base building, mechanical spaces, and limited other areas required by the inspector during construction. Coordinate these areas with the General Contractor.

C. Inspections and Tests: All inspections, examinations, and tests required by the authorities and/or agencies specified hereinbefore shall be arranged and paid for by this Contractor, as necessary, to obtain complete and final acceptance of the system as installed. The certificates of inspection shall be in quadruplicate, and shall be delivered to the Architect for distribution.

END OF SECTION 21 11 00
SECTION 22 01 00

GENERAL PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Provide the necessary interface with other Divisions to provide a complete project. Carefully check the Documents of this Division with those Documents of other Divisions. Determine the requirements of any interfacing materials or equipment being furnished and/or installed by those Sections and Divisions, and provide proper installation and required interface.

B. No deviation from the Contract Documents shall be made without the written consent of the Architect and Engineer.

C. All Specifications and Drawings are to be considered together as the Contract Documents. Any work shown in one and not the other, or is implied by either, shall be provided to make a complete project. Should conflicts exist between the Specifications and Drawings or there is an item shown or noted for which is not clearly defined, immediately submit a request for clarification. Under no circumstance will conflicts between the Specifications and Drawings be grounds for additional cost to the Contract after the Contract is established.

D. The Drawings are schematic and are not intended to show the exact location of piping, equipment, etc.

E. Dimensions and information regarding accurate locations of equipment, and structural limitations and finish shall be coordinated and verified with other Divisions of Work. Be prepared to furnish dimensions and information regarding the Work of this Division to other trades.

F. The right is reserved to relocate any device (receptacle, switch, fire alarm, audio/visual, junction box, outlet, etc.) a maximum of 10'-0" before it is permanently installed without incurring additional cost to the Contract.

1.02 REFERENCE STANDARDS

A. All work shall comply with the most recently revised versions of all local, state and federal codes, ordinances of the authority having jurisdiction, laws, rules and regulations. Any modifications required by any of the above shall be made without any additional cost to the Owner. Where requirements between governing Codes and Regulations vary, the more restrictive provision shall apply.

B. Nothing contained in the Contract Documents shall be construed as authority or permission to disregard legal requirements and regulations. The Contractor shall thoroughly review the Documents and bring any such conflicts to the attention of the Architect and Engineer prior to Installation.

C. All materials, installation, and workmanship shall comply standards and/or codes of the following:
   2. International Mechanical Code - 2012 edition, with latest Georgia amendments
8. National Fire Protection Association
10. ANSI - American National Standards Institute
11. ASTM - American Society of Testing and Materials
12. NEMA - National Electrical Manufacturer’s Association
13. OSHA - Occupational Safety and Health Act
14. UL - Underwriter’s Laboratories
15. ASHRAE - American Society of Heating and Air Conditioning Engineers
16. SMACNA - Sheet Metal and Air Conditioning Contractors’ Nat’l Assoc.

D. All materials shall be new and shall bear the label of UL.

1.03 DEFINITIONS

A. Provide: to furnish, install and connect.

B. Furnish: to supply all materials, labor, equipment, testing apparatus, controls, tests, accessories and all other items customarily required for the proper and complete application.

C. Install: to join, unite, fasten, link, attach, set-up or connect together, complete, tested, and ready for normal satisfactory operation.

D. Engineer: the Engineer of record.

E. Contract Documents: the complete set of Specifications and Drawings of all Divisions.

F. Work: labor, materials, equipment, accessories, controls and other items required for a complete installation.

G. Concealed: embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces or in enclosures.

H. Exposed: not installed underground or concealed.

I. Equal: equal in quality, workmanship, materials, weight, size, design and efficiency of the specified product, conforming with manufacturers.

J. Supply: to purchase, procure, acquire and deliver complete with related accessories.

K. Authority Having Jurisdiction (AHJ): applicable local, state and federal authorities having jurisdiction over any part of the Scope within this Division and other Divisions.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturer’s names and catalog numbers specified in the Contract Documents are intended to describe the material and set the standard of quality. All bids shall be based on material specified. Request for approval of material not specified shall be considered if the request is in written form and submitted to the Architect no later than fourteen (14)
days prior to the bid date. All requests shall conform to the provisions of the general and supplementary conditions.

B. When specific names are not stated, only the best available quality of material or equipment shall be submitted for review and used in the installation.

2.02 BASIS OF DESIGN

A. Where a product is designated as "BASIS OF DESIGN", the Contractor is notified that mechanical, electrical, structural, architectural, space conditions and/or other features of the overall project design have been based on the requirements of the "BASIS OF DESIGN" product.

B. Where a product is substituted for a "BASIS OF DESIGN" product, the Contractor is notified that changes in project design may be mandatory in order to permit use and installation of the substitute product. Shop drawing submittal for a substitute product shall include a complete schedule of changes in project design, if any, which must be made in order to permit use and installation of the substitute product. The Contractor shall bear all expenses related to the use of a substitute product.

2.03 SHOP DRAWINGS AND PRODUCT DATA

Refer to SRSS Section 01 33 00.

2.04 AS-BUILT DRAWINGS

Refer to SRSSA section 01 78 39 - Project Record Documents.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The equipment selections used in the preparation of the Contract Documents will fit into the physical spaces provided and indicated, allowing ample room for access, servicing, removal and replacement of parts, etc. Adequate space shall be allowed for clearance in accordance with the Code requirements and the requirements of the local Authorities having jurisdiction, and the equipment manufacturer's recommendations.

B. In the preparation of Drawings, a reasonable effort to accommodate acceptable equipment manufacturer's space requirements has been made. However, since space requirements and equipment arrangement vary according to each manufacturer, the responsibility for initial access, maintenance access, code required access, and proper fit rests with the Contractor.

C. Physical dimensions and arrangements of equipment to be installed shall be subject to the Architect's and Engineer's review.

D. The General Contractor and all Subcontractors shall coordinate the installation of ductwork, conduit, busway, piping, cable trays, etc., installation with lighting fixtures, special ceiling construction, air distribution equipment, and the structure. Provide additional rises, drops and offsets as required. If after installed, new ductwork, conduit, busway, piping or cable is found to be in conflict with the architecture, structure, or other trade Work which is either existing or shown on the Contract Documents, the ductwork, conduit, busway, piping or cable shall be relocated without additional cost to the Owner.
E. No piping, equipment, etc., shall be installed in the eight (8) inch high zone directly above
the ceiling in tenant areas to allow for tenant build-out and flexibility unless otherwise
specifically shown on the Drawings or prior written authorization is received from the
Engineer.

F. Accessibility and Clearance:
   1. Piping, etc. shall be installed in accessible locations, avoiding obstructions,
      preserving headroom, and keeping openings and passageways clear.
   2. Minor adjustments in the locations of equipment shall be made where necessary,
      providing such adjustments do not adversely affect functioning of the equipment.

G. Scaffolds and staging for installation of plumbing work shall be provided under the work
   of this Division.

3.02 STRUCTURAL FITTINGS

A. Furnish and install the necessary sleeves, inserts, hangers, anchor bolts, and related
   structural items. Install at the proper time.

B. Openings may have been indicated on the Architectural and Structural drawings. Should
   any additional openings or holes be required, the same shall be provided at no additional
cost to the Owner.

C. Location: At a time in advance of the work, verify openings shown on the Architectural
   and Structural drawings, and coordinate any additional openings.

D. If the work of this Section requires modification of the Architectural or Structural drawings,
furnish new instructions as to requirements for these openings. Submit for review and
   coordination to Architect.

E. Sleeves shall be supplied for mechanical piping passing through walls or slabs and shall
   be placed before concrete is poured.

F. Equipment supports for mechanical work shall be fastened to the structure by inserts,
   anchor bolts, bolting to drilled and tapped structural members, or be welded to the
   structure.
   1. Welding shall be done by the electric arc method with fully competent welders.
      Supporting members shall be shop coated with a suitable primer.
   2. Surfaces damaged by installation of supports shall be touched up with primer to
      match shop coat. Any drilling of structural members shall be approved by the
      Architect.

G. Flashing:
   1. Wherever piping passes through the roof or outer walls, base flashing and counter-
      flashing shall be provided.
   2. Such flashing shall be properly installed by skilled workmen, and shall include
      grouting, mastic or tar application, or other means to insure a permanent, waterproof,
      neat and workmanlike installation.
   3. Insofar as possible, flashing shall comply with and be similar to requirements for
      flashing in General Construction Work.

H. Anchor bolts and inserts shall be galvanized and of adequate size and strength for
   installation of electrical work and shall be placed in forms before concrete is poured.
   1. Placement of bolts in bases shall be done under other Division. Furnish detail
      drawings, templates, and anchor bolts for bases to the General Contractor in time
to avoid delaying work schedules.
2. Expansion shields shall only be used with specific approval of the Architect. Wooden or soft metal plugs shall not be used.

I. Cutting and patching:
1. All additional cutting, patching and reinforcement of construction of building, subject to review by the Architect, shall be performed under this Section.
2. Refer to appropriate Division for requirements.

3.03 WEATHERPROOF EQUIPMENT

A. Plumbing devices or equipment located in damp, semi-exposed areas shall be weather-resistant. Enclosures shall comply with NEMA Type 3R requirements.

B. Air distribution devices located in damp areas outside shall be weather-resistant (aluminum, etc.).

3.04 CLEANING

A. Brush and clean work prior to concealing, painting and acceptance. Perform in stages if directed.

B. Painted exposed work soiled or damaged: Clean and repair to match adjoining work before final acceptance.

C. Remove dust and debris from inside and outside of material and equipment.

3.05 TESTS AND DEMONSTRATIONS

A. All systems shall be tested in the presence of the Owner or an Owner designated representative upon completion of the Work and demonstrates that the installation is in accordance with the Contract Documents.

B. All motors shall be checked and adjusted for correct direction of rotation.

C. Any work found not to be in compliance with the Contract documents shall be repaired or replaced without incurring additional cost to the Contract price.

D. Provide all instruction to the Owner on maintenance and operation of all systems and equipment provided under this Division.

3.06 WARRANTIES

A. The warranty period for all systems, equipment, components, work, etc. shall be no less than one (1) year, unless specified otherwise hereinafter and shall include at least one (1) full heating season and one (1) full cooling season. The warranty shall include parts and labor.

B. The Contractor shall, without cost to the Owner, remedy any defects within a reasonable time to be specified in notice from the Architect. In default thereof, the Owner may have such work done and charge all costs to the Contractor.

C. The start of the Contractor’s warranty period, as defined in the General Conditions, shall commence on the issue of a “Certificate of Substantial Completion”, by the Owner or the Owner’s Representative for each item of material, equipment or system.
D. The Subcontractor shall confer with the General Contractor prior to the bid date concerning the project schedule and determine if there is a need to operate any items of equipment or systems for temporary heating and/or cooling or other reasons prior to “Substantial Completion”. All required extended warranty costs for equipment, materials, and systems shall be included in the Subcontractor’s bid.

END OF SECTION 22 01 00
SECTION 22 05 29
HANGERS & SUPPORTS FOR PLUMBING
PIPING & EQUIPMENT

PART 1 – GENERAL

1.01 RELATED DOCUMENTS
A. The Conditions of the Contract and applicable requirements of Division 1, “General Requirements”, and Section 22 01 00 “General Plumbing Requirements”, govern this Section.

1.02 DESCRIPTION OF WORK
A. Work Included: Provide pipe hangers, supports, and required appurtenances as specified and indicated

1.03 QUALITY ASSURANCE
A. MSS Standard Compliance: Provide pipe hangers and supports of materials, design, and manufacture which comply with ANSI/MSS SP-58, SP-59, SP-89, and SP-90.

B. Acceptable Manufacturers: The model numbers listed in the Specification establish a level of quality and material. Subject to compliance with requirements, provide products and materials by the following:
1. ITT Grinnell Corporation,
2. Fee and Mason,
3. Central Iron Manufacturing Company, and
4. F & S Manufacturing Company
5. Anvil International
6. B-Line

PART 2 – PRODUCTS

2.01 PIPE HANGERS AND SUPPORTS:
A. General: Provide pipe hangers and supports as specified. Comply with local codes and standards for pipe and equipment support and anchorage. Pipe supports shall be of material that will prevent electrolytic action.


C. Piping in Multiple Parallel Runs: Provide Grinnell No. 45 or No. 50 with Grinnell No. 137 U-bolt pipe clamps or structural channels or angles with U-bolt clamps, supported as trapeze hangers where multiple parallel runs of piping are shown. Select and size members for weights to be carried and span dimensions between supports.

D. Piping in Single Runs: Provide Fee and Mason Fig. 239 or Grinnell No. 260 clevis hanger.
E. Hanger Rod: Provide hanger rods of required length. Rod diameters shall be as listed in the following table. Rod diameters may be adjusted after consultation with the Structural Engineer concerning the building framing system, the method of attachment to the structure and the support rod spacing.

<table>
<thead>
<tr>
<th>Pipe Sizes</th>
<th>Rod Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4” - 2”</td>
<td>3/8”</td>
</tr>
<tr>
<td>2-1/2” – 3</td>
<td>1/2”</td>
</tr>
<tr>
<td>4” – 5</td>
<td>5/8”</td>
</tr>
<tr>
<td>6”</td>
<td>3/4”</td>
</tr>
<tr>
<td>8” – 12”</td>
<td>7/8”</td>
</tr>
</tbody>
</table>

F. Riser Clamps: Provide Fee and Mason Figure 241 riser clamps. Riser clamps for copper tube shall be copper-plated.

G. Saddles and Shields:
1. Saddles for Horizontal Insulated Piping without Vapor Barrier: At each hanger or support on horizontal runs, provide Grinnell No. 160 or Fee and Mason Figure 171, 1710, 1712, or 172 saddles, as applicable. Shields as described below may be used instead of the saddles. On heating water systems below 140°F (60°C), hangers may be sized for the pipe size and of a material compatible with the pipe. Where dissimilar materials are used, provide dielectric separation. Carry insulation over the hanger and seal where hanger is sized for pipe.

2. Shields for Horizontal Insulated Water Piping with Vapor Barrier: At each hanger or support for water piping, provide a half section of preformed 6 PCF density fiberglass or rigid calcium silicate, with jacket of adjacent insulation brought across unbroken, supported on semicircular 16 gauge shields. Shields for pipe 4” and smaller shall be 12” long; shields for pipe 5” to 8” shall be 18” long; and shields for larger pipe shall be 24” long.

H. Piping on Roof: Roof mounted pipe supports are discouraged. If roof supports are necessary, installation methods must be approved by the architect, engineer, general contractor, and the Roofing Contractor.

PART 2 – EXECUTION

3.01 INSTALLATION:

A. Independent Support: Support fire sprinkler and standpipe piping independently of other piping in accordance with NFPA-approved methods and local codes and standards.

B. Provisions for Movement:
1. Movement: Install hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate the action of expansion joints, expansion loops, expansion bends, and similar units.
2. Load Distribution: Install hangers and supports so piping live and dead loading stresses from movement will not be transmitted to any pipe or connected equipment. Pipe supports shall properly transmit the weight of the pipe and its contents to the building structure, or to independent posts, piers, or foundations.
3. Pipe Slopes: Install hangers and supports to provide the indicated pipe slopes so maximum pipe deflections allowed by ANSI B31 are not exceeded.

C. Insulated Piping: Comply with the following installation requirements:
1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through the insulation; do not exceed pipe stresses allowed by ANSI B31.

2. Shields: Where low-compressive-strength insulation of vapor barriers are indicated on cold, chilled, or heating water piping, install coated protective shields. For pipe 8" and over, install rigid calcium silicate insulation between saddles and pipe.

D. Spacing: Install hangers and supports in piping systems to remove stress from equipment flanges and rotating equipment. Space hangers and supports as shown in the following table. Rod spacing may be adjusted after consultation with the Structural Engineer concerning the building framing system, the method of attachment to the structure and the support rod diameters.

<table>
<thead>
<tr>
<th>Trade Pipe Size</th>
<th>Maximum Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2&quot;</td>
<td>5'</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>6'</td>
</tr>
<tr>
<td>1&quot; and 1-1/4&quot;</td>
<td>7'</td>
</tr>
<tr>
<td>1-1/2&quot;</td>
<td>9'</td>
</tr>
<tr>
<td>2&quot;</td>
<td>10'</td>
</tr>
<tr>
<td>2-1/2&quot;</td>
<td>11'</td>
</tr>
<tr>
<td>3&quot;</td>
<td>12'</td>
</tr>
<tr>
<td>4&quot;</td>
<td>14'</td>
</tr>
<tr>
<td>5&quot;</td>
<td>16'</td>
</tr>
<tr>
<td>6&quot;</td>
<td>17'</td>
</tr>
<tr>
<td>8&quot;</td>
<td>19'</td>
</tr>
<tr>
<td>10&quot;</td>
<td>22'</td>
</tr>
<tr>
<td>12&quot;</td>
<td>23'</td>
</tr>
</tbody>
</table>

E. Saddles: Where insulation without vapor barrier is indicated, install protection saddles, or use hangers as indicated in Paragraph 2.0/H.1.

F. Guides: Install pipe guides complying with the manufacturer's published product literature. Where not otherwise indicated, install pipe guides near expansion loops, expansion joints, and ball joints.

G. Anchors: Install anchors at the proper locations to prevent stresses from exceeding those permitted by ANSI B31 and to prevent the transfer of loading and stresses to connected equipment. Anchors shall include vibration isolation in accordance with the pipe support system specified. Where the piping system is floating, the anchors shall be termed restraints or braces.

1. Where expansion compensators are indicated, install anchors in accordance with the expansion unit manufacturers written instructions, to limit movement of piping and forces to the maximums recommended by the manufacturer of each unit.

2. Where not otherwise indicated, install anchors at the ends of principal pipe runs and at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required accommodating both expansion and contraction of piping.

H. Leveling: Adjust hangers and supports and place grout as required under supports to bring piping to proper levels and elevations.

I. Hangers: Refer to Section 23 05 48, "Vibration Isolation", for additional information and support requirements. Pipe hangers made of wood, wire, or sheet iron shall not be permitted.
J. Riser Supports: Vertical piping shall be secured at sufficiently close intervals to keep the pipe in alignment and carry the weight of the pipe and contents.
   1. Cast iron soil pipe shall be supported at the base and at each story level, but in no case at intervals greater than 10’.
   2. Steel pipe shall be supported at the base and at no less than every other story level, but in no case at intervals greater than 25’.
   3. Copper tube shall be supported at each story level, but in no case at intervals greater than 10’.
   4. Plastic pipe shall be supported at mid point between floors and at ceiling to prevent movement, but in no case at intervals greater than 8’.

END OF SECTION 22 05 29
SECTION 22 05 53
IDENTIFICATION FOR PIPING AND EQUIPMENT

PART 1 – GENERAL

1.01 SUMMARY

A. The General Provisions, Supplemental General Provisions, section 22 01 00, Division 1 Specifications and Special Provisions apply to all Work specified in this Section.

B. This section describes the basic materials and installation methods for the identification of equipment and piping. Comply with other Division 15 sections and drawings as applicable. Refer to other divisions for coordination of work.

C. Furnish and install all components of the identification of equipment and piping specified herein and/or as indicated on the drawings.

1.02 DESCRIPTION OF WORK

A. Work Included: Identification of mechanical equipment shall consist of equipment labeling, pipe marking, and valve tagging as specified hereinafter.
   1. In general, all equipment shall be labeled. This shall include all central plant, air handling or air conditioning equipment, and other similar and miscellaneous equipment.
   2. Pipe markings shall be applied to all piping.
   3. Each valve shall be identified with a stamped tag. Valves and tagging shall be scheduled typewritten on 8 ½” x 11” paper, tabulating valve number, piping system, system abbreviation, location of valve (Room or area), and service (e.g. – 2nd Floor North Domestic Hot Water). The valve schedule shall be submitted to the Engineer for approval prior to ordering or installing valve tags. See Section 23 01 00, “General Mechanical Requirements” for information and requirements regarding Operation and Maintenance Manuals.
   4. Labels, tags, and markers shall comply with ANSI A13.1 and other applicable state and local standards for lettering size, colors, and length of color field.
   5. Equipment and device identification specified in other sections shall be provided as a part of those requirements.

1.03 ACCEPTABLE MANUFACTURERS

A. Labels, markings, and tags shall be manufactured by W.H. Brady, Seton, Allen, or Industrial Safety Supply.

PART 2 – PRODUCTS

2.01 EQUIPMENT LABELING

A. Equipment labeling shall be one of the following, unless noted or specified otherwise:
   1. Permanently attached engraved brass or plastic laminated signs with 1” high lettering. Signs on exterior equipment shall be brass.
   2. Stencil painted identification, 2” high letters, with standard fiberboard stencils and standard black (or other appropriate color) exterior stencil enamel.

2.02 PIPE MARKINGS
A. On piping less than 6" diameter, install plastic semi-rigid snap-on type, manufacturer’s standard pre-printed color-coded pipe markers extending fully around the pipe and insulation or pressure-sensitive vinyl pipe markers similar to the above. Pipe markings can also be applied with the stick type backing in lieu of the semi-rigid snap-on-type.

B. On piping and insulation 6" and greater diameter, full band as specified above or strip-type markers fastened to the pipe or insulation with laminated or bonded application or by color-coded plastic tape not less than 1 ½" wide, full circle at both ends of the marker. Pipe markings can also be applied with the stick type backing in lieu of the semi-rigid snap-on-type.

C. Arrows for direction of flow provided integral with the pipe marker or separate at each marker.

2.03 VALVE TAGS

A. Valve tags shall be polished brass or plastic laminate with solid brass S hook and chain. Tags shall be stamped or engraved with the appropriate abbreviation for the type of service (e.g. – CHW, HW), as well as the designated valve number.

B. A valve schedule is to be provided to the Owner. For each page of valve schedules, a glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.

PART 3 – EXECUTION

3.01 GENERAL

A. Identification labeling, marking, and tagging shall be applied after insulation and painting has been completed.

B. Coordinate names, abbreviations, and other designations used in mechanical identification work with corresponding designations shown, specified, or scheduled on drawings. Prior to ordering any labels, markings, or tags, obtain the approval of the Engineer regarding names, abbreviations, etc.

C. The Plumbing, HVAC, and Fire Protection Contractors shall coordinate labeling, marking, and tagging to ensure consistent and coordinated identification. In existing buildings, utilize similar names, abbreviations, and other designations that are currently in use to remain consistent with existing identification.

D. Equipment labeling shall consist of unit designation as shown on the drawings. Exhaust fan labeling shall also indicate service or the room or area of service.

E. Pipe and ductwork markers shall be placed on piping and ductwork on 25’ centers in mechanical rooms and concealed spaces. In locations where piping and ductwork is exposed, place markers on 50’ centers. Flow directional arrows should be marked on the piping at taps from the main and riser.

F. Valve tags shall be placed on each valve except those intended for isolation of individual heat pumps or terminal units (e.g. - VAV boxes, fan coil units, unit heaters, etc.). Valve tag schedules shall be prepared as specified hereinbefore. Copies of one schedule shall
be laminated in clear plastic and placed where directed by the Owner. Other sets shall be included in the Operating and Maintenance Manuals.

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

PART 1 - GENERAL

1.01 SUMMARY
A. The General Provisions, Supplemental General Provisions, section 22 01 00, Division 1 Specifications and Special Provisions apply to all Work specified in this Section.

B. This section describes the basic materials and installation methods for the insulation of Plumbing piping and equipment. Comply with other Division 22 sections and drawings as applicable. Refer to other divisions for coordination of work.

C. Furnish and install all components of the insulation system specified herein, as indicated on the drawings, and as required to provide complete and operating systems.

D. All adhesives, mastics, glues, sealants, etc… shall meet the LEED requirements.

1.02 QUALITY ASSURANCE
A. Manufacturer: Approved manufacturers are Armstrong, Calsite, Cell-U-Foarm Corp, Ceelco, Certainteed Corp, Dow Chemical Company, Forrest Mfg Co, Foster / Chilers, Gemco, Johns Manville, Knauf Fiberglass, Midwest Fastners, Owens Corning Fiberglass, Pittsburg Corning Fiberglass, Rubatex, Trymer, and Venture Tape.

B. All insulation, jacket and adhesive shall have a fire and smoke hazard ratings as tested under ASTM E 84, NFPA 255, and UL 723 not exceeding:

<table>
<thead>
<tr>
<th>Flame Spread</th>
<th>25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel Contributed</td>
<td>50</td>
</tr>
<tr>
<td>Smoke Developed</td>
<td>50</td>
</tr>
</tbody>
</table>

Exceptions: Type B Insulation and PVC Fitting Covers

1.03 SUBMITTALS
A. Per Section 22 01 00.

B. Product Data
1. Type A Insulation
2. Type B Insulation
3. Type D Insulation
4. Type E Insulation
5. Type F Insulation
6. Vinyl Lacquer Paint for Type B Insulation
7. Metal Jacket

1.04 DEFINITIONS
A. The phrase “Storm Drainage Conductor” refers to that portion of the storm drain interior to the building, between the roof drain body and where the pipe goes below grade.

B. The word “plenum” shall mean a ceiling space or mechanical room used for the transfer of conditioned return and/or outside air.
PART 2 - PRODUCTS

2.01 PIPING INSULATION

A. Type A – Fiberglass (indoor)
   1. One Piece glass fiber, rigid molded sectional pipe covering with factory applied aluminum foil and white craft paper flame retardant vapor barrier jacket, conforming to ASTM C547, Class II, Mineral Fiber Preformed Pipe Insulation.
   2. Thermal Conductivity (k) equals approximately 0.23 (BTU/HR., SF., Degree F, IN) at 75 °F.
   3. Similar to Johns Manville Corp “Micro Lox 650 AP T”, or approved equal.

B. Type B - Closed Cell (indoor)
   1. Closed cell, flexible foamed plastic conforming to ASTM C534, "Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form." Insulation shall be suitable for a temperature range from –40 degrees F to 220 degrees F.
   2. Conductivity (k) equals approximately 0.27 (BTU/HR., SF., Degree F, IN) at 75 °F.
   3. Similar to Armstrong “Armaflex”, or approved equal.

2.02 EQUIPMENT INSULATION

A. Type E
   1. Calcium silicate block conforming to ASTM C 553, Type I (1200 degrees F. max), asbestos free.
   2. Conductivity (k) equals approximately 0.42 (BTU IN/HR., SF., degree F) per inch thickness at 200 °F.
   3. Similar to Calsilite, or approved equal.

B. Type F
   1. Insulation shall be 2" thick, minimum 3/4 lb. density fiberglass with an FSKL aluminum foil jacket, reinforced with fiberglass scrim.
   2. Conductivity (k) equals approximately 0.27 (BTUHR., SF., degrees F, IN) at 75 °F.
   3. Integral UL rated vapor barrier of:
      a. Aluminum foil reinforced with fiberglass scrim laminated to 30-lb. kraft paper.
      b. Class I white vinyl 0.004 inch thick, where specified.
   4. Similar to Johns Manville Corp “Microlite”, or approved equal

2.03 METAL JACKET

A. Smooth aluminum jacket 0.016 inch thick.

B. Integral polykraft or poly-surlyn moisture barrier.

C. Banded locking joints with field applied silicone weatherproof sealant.

D. Similar to Johns Manville Corp, or approved equal.

2.04 INSULATION ACCESSORIES

A. The following accessories shall be used in the application of the thermal insulations specified under this Section:
   1. PVC Fittings Covers: similar to Johns Manville Corp “Zeston”, or approved equal.
2. Pressure Sensitive polyester film tape to secure pipe insulation up to 12” outside diameter: Similar to 3M 30-80, or approved equal.
3. Vapor Seal Mastic: Similar to Childers CP-35, or approved equal.
4. Lagging Adhesive: Similar to Childers CP-52, or approved equal.
5. Wire: 16 gauge soft stainless steel.
6. Insulation Bonding Adhesive (To Metal): Similar to Childers CP-82, or approved equal.
7. Insulating and Finishing Cement: Similar to Insulco Smooth Kote, or approved equal.
8. Mechanical Fasteners - Welded or adhered pins with speed clip washers: Similar to Gemco Midwest Fasteners, or approved equal.
9. Bands for Equipment:
   a. Outside diameter of insulation is less than 24 inch: 1/2 inch x 0.020-inch (25 ga.) stainless steel.
   b. Where diameter is 36 inches or larger: 3/4 inch x 0.020 inch.
10. Bands for Piping: 1/2 inch x 0.020-inch stainless steel.

PART 3 - EXECUTION

3.01 INSULATION APPLICABILITY

A. Condensate Drains (except in plenums and fire partitions/floors) – Type B insulation required:

<table>
<thead>
<tr>
<th>Insulation Thickness (in)</th>
<th>Pipe Sizes (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2</td>
<td>all</td>
</tr>
</tbody>
</table>

B. Condensate Drains (inside plenums and fire partitions/floors) – Type A insulation required:

<table>
<thead>
<tr>
<th>Insulation Thickness (in)</th>
<th>Pipe Sizes (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2</td>
<td>up to 1</td>
</tr>
<tr>
<td>3/4</td>
<td>1-1/4 and up</td>
</tr>
</tbody>
</table>

C. Horizontal storm leaders, roof drain bodies, and underside of drains receiving condensate from cooling coils – Type F insulation required:

| Insulation Thickness (in) | Pipe Sizes (in) | |
|---------------------------|-----------------|
| 2                         | all             |

D. Horizontal waste piping from electric water coolers – Type A insulation required:

| Insulation Thickness (in) | Pipe Sizes (in) | |
|---------------------------|-----------------|
| 1/2                       | all             |

E. Refrigerant Suction Lines & Valves (except in plenums and fire partitions/floors) – Type B insulation required:

| Insulation Thickness (in) | Pipe Sizes (in) | |
|---------------------------|-----------------|
| 1                         | all             |

F. Refrigerant Suction Lines & Valves (in plenums and fire partitions/floors), and hot gas bypass piping – Type A insulation required:

| Insulation Thickness (in) | Pipe Sizes (in) | |
|---------------------------|-----------------|
| 1                         | all             |
G. Domestic Hot Water and Tempered Water – Type A insulation required:

<table>
<thead>
<tr>
<th>Insulation Thickness (in)</th>
<th>Pipe Sizes (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>all</td>
</tr>
</tbody>
</table>

H. Emergency Generator Exhaust Piping and Muffler – Type E insulation required:

<table>
<thead>
<tr>
<th>Insulation Thickness (in)</th>
<th>Pipe Sizes (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>all</td>
</tr>
</tbody>
</table>

I. Domestic Water Heaters shall be factory insulated.

J. Cold equipment – Type Dc insulation required, minimum 1/2". Consult with equipment manufacturer as thickness may vary depending on service application and equipment manufacturer installation recommendations.

K. Hot equipment – Type Dh insulation required, minimum 2". Consult with equipment manufacturer as thickness may vary depending on service application and equipment manufacturer installation recommendations.

Notes:

a. The above thicknesses are the minimum required. All local codes and local energy codes shall be complied with.

b. All piping exposed to outdoors shall be insulated. All piping subject to freezing shall be provided with heat tracing. Coordinate insulation with heat trace cable and controls.

c. Insulation types and thickness are a minimum standard. Each application shall be carefully considered and insulation product type and thickness shall be appropriate for each specific application. Submit all insulation products with verification of their service intent.

3.02 PIPING INSULATION GENERAL REQUIREMENTS

A. Preparation

1. Do not apply insulation until piping has been leak tested.

2. All surfaces to be insulated shall be dry and free of loose scale, rust, dirt, oil or water.

B. Application:

1. Insulation shall be installed in a smooth, clean workmanlike manner. Joints shall be tight and finished smooth without fish-mouts.

2. Insulation shall fit tightly against the surface to which it is applied to prevent air circulation between the insulation and the pipe or equipment to which it is applied.

3. Insulation applied to cold piping or equipment shall be completely vapor sealed, free of pinholes or other openings.

4. Do not use wet insulation materials.

5. All longitudinal joints on vertical pipe runs shall be staggered.

6. Apply insulation so as to permit expansion or contraction of pipelines without causing damage to insulation or surface finish.

7. Do not apply mastic or adhesive until all previous applications of mastic and adhesives have thoroughly dried.

8. No bands or staples shall be provided on covering.

9. The adhesive used in connection with all covering work shall contain an approved vermin and rodent proof ingredient.

10. Provide 24-gauge sheet-metal saddle between the pipe hanger/support and the exterior of the insulation. Saddle length shall be the same as insulation inserts.
C. Application at Fittings:
   1. Insulation of flanges and flanged fittings shall overlap adjacent pipe covering at least 1 inch. Valves shall be insulated up to the gland only.
   2. Pipeline strainers shall be insulated in such a manner as to permit removal of strainer basket without disturbing insulation of the strainer body.
   3. Insulation adjacent to un-insulated flanges shall be tapered back and neatly finished so as to allow access to and removal of bolts without injury to covering.

3.03 TYPE A INSTALLATION

A. Tightly butt together sections of insulation on pipe runs sealing longitudinal seams of jacket with a self-sealing adhesive. Seal end joints with 4-inch wide straps of matching vapor barrier tape. Seal off ends of insulation with vapor seal mastic at valves, fittings and flanges. No further finish required. Mastic shall extend onto the bare pipe and over the insulation O.D.

B. PVC fitting jackets shall be used when they are available for the particular application. When molded or routed coverings are not available, the coverings shall be fabricated in the field similar to equipment insulation. molded or routed fitting covers are highly recommended. Order PVC pre-curl ed.

C. Cold Piping:
   1. Cover valves, fittings and flanges with insulation having the same thickness as adjacent pipe covering, securing in place reforming tape up to 12” O.D. and ¼” wide SST bands on larger O.D. Apply a PVC jacket and seal joints with PVC cement (solvent welding).

D. Hot Piping:
   1. Covers shall overlap the pipe insulation by the thickness of the insulation or 2” min. Cover valves, fittings and flanges with insulation similar to the adjacent pipe covering, securing in place with reforming tape up to 12” O.D. and ¼” wide SST bands on larger O.D. Apply a PVC jacket and tape end joints to adjacent pipe insulation.

   2. Do not use PVC fitting jackets where the surface of the insulation is above 150 degrees F.

E. Exterior Piping:
   1. Exterior above grade water piping shall be finished with a weatherproof jacket and an aluminum jacket. Lap and seal joints as per manufacturer's instructions. Place laps to shed water.

3.04 TYPE B INSTALLATION

A. Type B insulation shall be slipped on the pipe prior to connection, and the butt joints shall be sealed. Where the slip on technique is not possible, the insulation shall be carefully slit and applied to the pipe.

B. All joints shall be completely butt sealed with the manufacturer's recommended adhesive.

C. Do not apply Type B insulation in multiple layers.

D. Type B insulation shall not be used in plenums nor firewall penetrations.

E. This Contractor shall paint Type B insulation exterior to the building with two coats of a vinyl acrylic paint recommended by the insulation manufacturer for protection against ultraviolet degradation and shall be flexible with no cracking. It is recommended in high humid areas to coat the insulation with a vapor barrier mastic to .037 min. DFT.
3.05 TYPE D INSTALLATION

A. Equipment Insulation Application:
1. Apply insulation to fit as closely as possible to equipment.
2. Stagger joints where possible.
3. Bevel insulation around nameplates, ASME stamp and access plates.
4. Insulation on equipment that must be opened periodically shall be constructed so insulation can be removed and replaced without damage.
5. Do not install Type E insulation on aluminum surfaces or with aluminum jacket.

B. Hot Equipment:
1. Install 3/4-inch expanded metal over equipment with standing ribs or seams prior to applying insulation to eliminate ribs or seams penetrating through the insulation.
2. Secure the insulation with steel bands spaced on 12-inch centers.
3. Where required, use welded studs, clips or angles as anchors for wire or bands on flat surfaces.
4. Seal joints with insulating cement.
5. Over the insulation stretch 1-inch hexagonal mesh wire and lace the edges together.
6. Apply a 1/4-inch thick coat of finishing cement and trowel smooth.
7. Smooth insulation with lagging adhesive, cover with glass cloth and a final coat of lagging adhesive.
8. On small equipment where it is not practical, omit the wire mesh and finishing cement on Type D insulation.

C. Cold Equipment
1. Cover irregular surfaces with a smoothing coat of insulating cement.
2. Secure insulation with wire or with stainless bands spaced on 12-inch centers.
3. Seal joints with vapor seal mastic.
4. Embed a layer of glass into a 1/16-inch coating of vapor seal mastic. Then coat the outside of the glass cloth with a 1/16-inch coating of vapor seal mastic.

D. Roof Drain Bodies
1. Insulate similar to cold equipment.
2. Insulated boxes around roof drain bodies are not acceptable.

3.06 TYPE F INSTALLATION

A. Insulation Application:
1. Apply insulation tightly and smoothly to pipe.
2. Secure insulation on the bottom of pipes and other places where the insulation will sag and max 3” from any place.
3. Impale insulation over pins or anchors located not more than 18 inches apart and hold in place with washers and clips. Or contractor shall wire wrap insulation to pipe.
4. Cut off protruding pin after clips are secured and seal with 2-mil. aluminum foil backed pressure sensitive tape.
5. Apply insulation with joints tightly butted.
6. Cover all breaks, joints, punctures and voids with a vapor seal mastic and cover with a vapor barrier material identical to vapor barrier on the insulation, where gaps exceed 2”.
7. Bevel insulation around nameplates, access plates and doors.
8. Insulation shall be continuous through walls and floors.

3.07 METAL JACKET INSTALLATION

A. Cover all piping insulation exposed to the exterior with metal jacket as specified herein.
3.08 HANGERS

A. Continue insulation through pipe hangers. Provide either rigid insulation inserts or sheet metal inserts at all outside pipe hangers. Provide rigid insulation inserts for piping operating below 60 °F. and sheet metal inserts for piping above 60 °F.

B. Provide rigid insulation (on non-insulated piping) or sheet metal inserts (on insulated piping) between the pipe and pipe hanger - shall be of a thickness equal to the adjoining insulation and shall be provided with vapor barrier where required. Insulation insert shall not be less than the following lengths:

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Insert Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2&quot; to 2 1/2&quot;</td>
<td>10 Inches Long</td>
</tr>
<tr>
<td>3&quot; to 6&quot;</td>
<td>12 Inches Long</td>
</tr>
<tr>
<td>8&quot; to 10&quot;</td>
<td>16 Inches Long</td>
</tr>
<tr>
<td>12&quot; and over</td>
<td>22 Inches Long</td>
</tr>
</tbody>
</table>

C. Inserts for cold piping shall have a vapor barrier facing of the same material as the adjacent pipe insulation. Seal inserts into insulation with vapor seal mastic.

D. Sheet metal inserts shall be of steel sheet. Gauge shall conform to manufacturer's recommendation for pipe size. Sheet metal inserts shall have insulation filler of the same material as the adjacent pipe insulation.

3.09 PIPE SLEEVES

A. Pipe insulation and vapor barrier shall be continuous through sleeves in walls and floors.

B. Type B insulation shall not be used in sleeves through firewalls or fire rated (2-hour) floor systems. Use Type A or Type C through the sleeve instead and vapor seal the joint between the two insulations.

C. Provide 26 gauge galvanized steel or 0.020 inch aluminum jacket over insulation on pipe passing through sleeves where sealant is required.

D. Where penetrating interior walls, extend the metal jacket 2 inches out either side of the wall and secure each end with a metal band compressing the insulation slightly.

E. Where penetrating floors, extend the metal jacket 2 inches below the floor and 5 inches above the floor. Secure with metal bands.

END OF SECTION 22 07 00
PART 1 - GENERAL

1.01 SUMMARY

A. The General Provisions, Supplemental General Provisions, section 22 01 00, Division 1 Specifications and Special Provisions apply to all Work specified in this Section.

B. This section describes the basic materials and installation methods for the plumbing piping systems. Comply with other Division 22 sections and drawings as applicable. Refer to other divisions for coordination of work.

C. Furnish and install all components of the plumbing piping systems specified herein, as indicated on the drawings, and as required to provide complete and operating systems.

1.02 DESCRIPTION OF WORK

A. Work Included: Provide complete operating plumbing piping systems including pipe, tube, fittings, and appurtenances as indicated and in compliance with these Specifications.

B. Applications: Applications of piping systems include, but are not limited to, the systems as listed below:

<table>
<thead>
<tr>
<th>Working System</th>
<th>Operating Pressure</th>
<th>Temperatures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic Cold Water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>350 psig</td>
<td>55 to 80°F</td>
</tr>
<tr>
<td>Medium</td>
<td>300 psig</td>
<td>55 to 80°F</td>
</tr>
<tr>
<td>Low</td>
<td>150 psig</td>
<td>55 to 80°F</td>
</tr>
<tr>
<td>Domestic Hot Water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>350 psig</td>
<td>90 to 120°F</td>
</tr>
<tr>
<td>Medium</td>
<td>300 psig</td>
<td>90 to 120°F</td>
</tr>
<tr>
<td>Low</td>
<td>150 psig</td>
<td>90 to 120°F</td>
</tr>
<tr>
<td>Makeup Water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>350 psig</td>
<td>55 to 80°F</td>
</tr>
<tr>
<td>Medium</td>
<td>300 psig</td>
<td>55 to 80°F</td>
</tr>
<tr>
<td>Low</td>
<td>150 psig</td>
<td>55 to 80°F</td>
</tr>
<tr>
<td>Sanitary Drainage</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Storm Drainage</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

1.03 QUALITY ASSURANCE

A. Welding: Qualify welding procedures, welders, and operators in accordance with ANSI B31.1, Paragraph 127.5, for shop and job site welding of piping work. Make welded joints on the piping system with continuous welds, without backing rings and with pipe ends beveled before welding. Gas cuts shall be true and free from burned metal. Before
welding, surfaces shall be thoroughly cleaned. The piping shall be carefully aligned and no weld metal shall project inside the pipe.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

A. General: Provide pipe and tube of type, joint, grade, size, and weight (wall thickness, schedule or class) indicated for each service. Comply with applicable governing regulations and industry standards.

1. Steel Pipe: ASTM A53, ASTM A106, or ASTM A120, black or hot-dipped galvanized as specified.
2. Copper Tube: ASTM B88, Types "K", Type "L", or Type "M" copper water tube as defined by the Copper and Brass Research Association.
6. Polyvinyl Chloride (PVC) Pipe: Sewer main SDR 41, ASTM D3034 with bell ends and pre-inserted gasket joints.
7. Polyvinyl Chloride (PVC) Water Pipe: Class 150, thickwall, Schedule 80, AWWA C90 mechanical joint.
8. Chlorinated Polyvinyl Chloride (CPVC) Drainage Pipe: Schedule 40 CPVC. Type IV Grade I with cell classification of 23447 as defined in ASTM D1784. Rated for temperatures up to and including 200°F.
9. PEX piping water Pipe: PEX-a piping and fittings.

2.02 PIPE / TUBE FITTINGS

A. General: Provide factory-fabricated fittings of type, materials, grade, class, and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, valve, and equipment connections. Where not otherwise indicated, comply with governing regulations, industry standards, and where applicable, with pipe manufacturer’s instructions for selections.

1. Cast Iron Flanged Fittings: ANSI B16.1, Class 125 or Class 250, black or galvanized as specified, including bolting and gasketing.
2. Cast Iron Threaded Fittings: ANSI B16.4 or ASTM A126, Class 125 or Class 250, black or galvanized as specified.
3. Malleable Iron Threaded Fittings: ANSI B16.3, Class 150 or Class 300, black or galvanized as specified.
4. Malleable Iron Threaded Unions: ANSI B16.39, select for proper piping fabrication and service requirements including style, end connections, and metal-to-metal seats (iron, bronze, or brass), plain or galvanized as specified.
6. Steel Flanges/Fittings: ANSI B16.5, including bolting, gasketing, and butt weld end connections.
7. Forged Steel Socket-welding and Threaded Fittings: ANSI B16.11, rated to match schedule of connected pipe.
8. Wrought Steel Butt-welding Fittings: ANSI B16.9, except ANSI B16.28 for short radius elbows and returns; rated to match connected pipe.
10. Pipe Nipples: Fabricated from same pipe as used for connected pipe, except do not use less than Schedule 80 pipe where length remaining unthreaded is less than 1/2". Do not thread nipples full length (no all-thread nipples).
15. Lead/Oakum Joint Materials: Comply with governing regulations for service use indicated.
16. Grooved End Fittings: ASTM A47 or ASTM A536 joined with Victaulic Style 77 couplings and Grade "E" gaskets.
18. Flange Bolts: Bolts shall be carbon steel ASTM A307 Grade A hexagon head bolts and hexagonal nuts. Where one or both flanges are cast iron, furnish Grade B bolts. Cap screws utilized with flanged butterfly valves shall be ASTM A307 Grade B with hexagon heads.
19. Flange Bolt Thread Lubricant: Lubricant shall be an anti-seize compound designed for temperatures up to 1000°F and shall be Crane Anti-Seize Thread Compound or approved equal.
20. Polyvinyl Chloride (PVC) Fittings: ASTMD-2665, Lasco or Spears Manufacturing high strength sewer fittings.
21. Copper Drainage Fitting: DWV copper drainage fittings.

B. Miscellaneous Piping Materials/Products:
3. Gaskets for Flanged Joints: 1/8" thick gaskets. Ring-type shall be used between raised face flanges and full face-type between flat face flanges with punched bolt holes and pipe opening. Gaskets shall be Garlock Style 3400 compressed non-asbestos or equal.
4. Insulating (Dielectric) Unions: Provide dielectric unions at all pipe connections between ferrous and nonferrous piping. Unions shall be "Delvin" as made by Pipeline Seal and Insulator Company or "EPCO" as made by Epco Sales, Inc. and shall have nylon insulation or equal.
7. Hub-less Cast Iron Joints: CISPI 310, stainless steel corrugated shield and clamp assembly over one piece neoprene sealing sleeve.

PART 3 - EXECUTION

3.01 PIPING INSTALLATION

A. General:
1. Industry Practices: Install pipe, tube, and fittings in accordance with recognized industry practices which will achieve permanently leak-proof piping systems, capable of performing each indicated service without failure or degradation of service. Install each run with a minimum of joints and couplings, but with adequate and accessible unions or flanged connections to permit disassembly for maintenance/ replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align accurately at connections. Coordinate piping locations with other trades to avoid conflict. Give ductwork preference unless directed otherwise by the Engineer.
2. Systems: Install piping parallel or perpendicular to lines of building, true to line and grade, and with sufficient hangers to prevent sags between hangers. Provide fittings at changes in direction. Piping in finished areas shall be concealed, except in mechanical rooms. Where pipes of different sizes join, provide reducing elbows, tees, or couplings. Bushings will not be acceptable.

3. Expansion and Contraction: Install loops, offsets, sizing joints, and expansion joints, as necessary, to avoid strain resulting from expansion and contraction of piping systems on fixtures and equipment. Provide mechanical grooved connections required by the application to reduce vibration at equipment connections. Provide expansion joints in piping systems by mechanical grooved connections where required.

B. Steel Pipe: Ream steel pipe after cutting and before threading. Thread with clean-cut taper threads of length to engage all threads in fittings and leave no full-cut threads exposed after make-up.

C. Copper Pipe: Cut copper pipe square and ream to remove burrs. Clean fitting socket and pipe ends with sand cloth or wire brush.

D. PVC Pipe: Cut PVC pipe square and remove all burrs. Clean fitting and pipe butt prior to installation. Install all PVC piping in accordance with the manufacturer's recommendations.

E. Final Connections to Equipment Furnished by Owner or Under Other Divisions of These Specifications: Where equipment is to be furnished under other Divisions of these Specifications or by the Owner, such equipment will be delivered to the site, uncrated, assembled, and set in-place under those other Divisions of these Specifications or under the separate contracts. Any required automatic control valves shall also be provided under those other Divisions of these Specifications or other separate contracts. Make all final connections of hot water, condenser water, gas, domestic water, waste, and vent as required. Provide valves, unions, strainers, check valves, and traps as required for proper operation of systems and equipment. Equipment not shown on the Architectural Drawings or noted by the Architect and/or Engineer shall not be included in the scope of this requirement.

F. Excavation, Installation, and Backfill for Underground Pipe:
   1. Layout: Pipes shall be laid and pipe joints made in presence of the General Contractor and field measurements, layouts, batter board alignment, grade establishments, and similar locations shall be performed by a Professional Engineer in the employ of the Contractor. The Contractor's engineer shall be on the job during all underground work. A "Bench-Mark" reference shall be provided by the General Contractor.
   2. Pipe Grading: Lay and maintain all pipes at required lines and grades during the course of the Work.
   3. Trench: Excavate the trench to the depth required. Properly brace and de-water the trench and keep it free of water during installation, testing pipe, and backfilling. No water shall be discharged onto the street or freeway without approval by the Owner.
   4. Excavation: The trench shall be at least 18" wider than the maximum diameter of the pipe or largest bell and the pipe shall be laid in the center of the trench. The trench shall be excavated to a depth sufficient to provide for pipe cushions or supports as specified. Trench width may be increased as required and piling left in place until sufficient compacted backfill is in place. Properly sheet and brace all open trenches to render them secure and remove all such sheeting and bracing before completing the backfill. Comply with all applicable national, state, and local codes and regulations. The quantity of excavation required to install sheeting and the installation and removal of sheetings and bracings will not be regarded as Extra
Work. All costs incurred for this excavation and the installation of sheeting shall be included in the Contract Price.

5. Grading: Upon completion of excavation and prior to the laying of the pipe, the trench bottom shall be brought up to the required elevation with a pipe cushion, except where the cushion has been eliminated by the General Contractor. Pipe cushions shall be select material deposited in the trench and shall be compacted, leveled off, and shaped to obtain a smooth compacted bed along the laying length of the pipe. Pipe cushion material shall be as follows:
   a. Domestic Water Pipes: Material for pipe cushion shall comply with local codes and conform with the geo-technical report. In absence of local code requirements and/or geo-technical report, the cushion shall be bank sand or select backfill material approved by the General Contractor. Any material used shall pass a one-inch screen.
   b. Sanitary and Storm
   c. Sewers: Material for pipe cushion shall comply with local codes and conform with the geo-technical report. In absence of local code requirements and/or geo-technical report, the cushion shall be bank sand or select backfill material approved by the General Contractor. Any material used shall pass a one-inch screen.

6. Anchors: Cast iron pipes shall have concrete anchors at each change in direction and/or as directed. Any change in direction exceeding 15 degrees shall be anchored. Concrete anchors shall rest against solid (virgin) ground with the required area of bearing on pipe and ground to provide suitable anchoring.

7. Backfill: Backfill trenches only after piping has been inspected, tested, and approved by the General Contractor. Backfill shall be provided as recommended in the geo-technical report included in these Contract Documents, or in the absence of a geo-technical report, as required by site conditions. Refer to Division 2 or elsewhere in the Contract Documents for additional trenching and backfill requirements.

8. Existing Surfaces: Restore existing streets, driveways, and sidewalks damaged during the excavation work to acceptable condition, subject to approval by the Owner.

9. Safety: Provide street and sidewalk excavations with approved barricades, warning lights, and cover plates as required by the local authorities.

3.02 PLUMBING SERVICES

A. Scope:
   1. This Contractor shall provide the building sanitary sewer to 5 feet outside the building and shall extend the domestic water service from the main shutoff valve stubbed above floor in the building.
   2. Provide storm drainage system as required to 5 feet outside the building.
   3. Verify locations and conditions.

B. General: Install the various piping systems as described hereinafter, and as required by the local plumbing inspection department.
   1. Slope domestic hot and cold water piping to drain and provide with hose valves (drain valves) at low points.
   2. Install soil, waste, and vent piping with horizontal lines pitched in accordance with local codes, but in no case less than 1/4" per foot for pipe 3" and smaller, and 1/8" per foot for pipe 4" and larger. Install soil, waste, and vent piping with hubs of each length of piping in the upstream position.
   3. Make-up lead and oakum joints with molten lead run into hubs in one continuous pour, to a minimum depth of one inch.
   4. Make-up "Ty-Seal" or "Dual-Tite" gasketed joints using lubrication and joining tools as instructed by the manufacturers. Base of stacks, horizontal runs under pressure, and gasketed pipe 5" and larger shall be made up using "Lubrifast" joining material.
5. Torque "No-Hub" joints in accordance with manufacturer's instructions. Do not install "No-Hub" joints below ground.
6. Provide chrome-plated piping at each fixture installed in a finished space. Install with proper strap wrenches to avoid marking or defacing.
7. Provide proper restraints on riser and stack offsets.

C. Plumbing Connections to Fixtures and Equipment:
   1. General: Provide necessary pipe and fittings. Make final connections to provide cold water make-up and natural gas supply to mechanical equipment. Locate cold water make-up and gas supply where shown and connect with suitable stop valves.
   2. Cold Water Make-up: Provide cold water make-up to closed loop condenser water circulating systems, cooling tower system, and hot water heating systems.
   3. Gas Supply: Provide gas supply separately metered to an approved location for future routing to kitchen locations.

D. The domestic water service shall be Class 150 AWWA cement lined C.I. with Class 250 fittings, mechanical joints or push-on rubber ring gaskets, ASTM A377-66 or PVC AWWA C900 with solvent welded fittings. Provide tie rods and thrust blocks as required.

3.03 DOMESTIC HOT AND COLD WATER PIPING SYSTEMS

A. Interior Hot and Cold Water Piping in Pump Room and Water Heater Room:
   1. Piping 3" and smaller, Type "L" copper tubing with wrought copper solder end fittings. At the Contractor's option, this piping may be as specified for piping 4" and larger.
   2. Piping 4" and larger, Schedule 40, galvanized steel pipe, ASTM A120 with galvanized malleable iron fittings, or galvanized cast iron flanged fittings.
   3. Provide isolation fitting whenever dissimilar materials are used.
   4. Option: At the Contractor's option, for piping 3" or larger, Victaulic Style 77 couplings, Victaulic fittings and tees may be used instead of the above, if Victaulic groove depth control tool is used for field grooving. Victaulic flanges and reducing couplings shall not be installed.
   5. Piping Run-outs to Fixtures: Provide piping run-outs to fixtures sized to comply with governing regulations. Each fixture shall be provided with a shut-off valve for each supply line. Provide all shutoff valves necessary to isolate mains to each restroom. Exposed lines shall be chromium-plated.

B. Interior Hot and Cold Water Piping outside of the Pump Room and Water Heater Room:
   1. Schedule 40 CPVC with NetLag acoustic insulation on laterals over public spaces.
   2. Provide add alternate pricing to switch piping exiting the pump room to PEX-a piping. Piping in each guest room or back to back guestrooms will have PEX-a manifolds for hand sinks.

C. Air Chambers: Provide the necessary air chambers, shock absorbers, or water hammer arrestors, specifically sized for the application to prevent water hammer.
   1. All water hammer arrestors shall be PDI certified, size A, B, C, D, E, F, as indicated and/or as appropriate for the fixtures served. Josam, Zurn, or Jay R. Smith.
   2. Water hammer arrestors shall be installed at the top of each riser, and on each fixture branch, with quick closing valves, in accordance with Plumbing and Drainage Institute Standard WH201.

3.04 UNDERGROUND DOMESTIC WATER SERVICE & FIRE PROTECT. PIPING

A. Piping Two-and-a-half Inches and Smaller: Type "K", copper tubing with wrought copper brazed end fittings.
B. Piping Three Inches and Larger: Ductile iron bell and spigot, push-on joint, pressure water pipe. Joints shall be of the push-on-type employing a molded rubber gasket retained in a ring recessed into the inside of the bell. Pipe and joints shall be manufactured by Tyler Pipe and Foundry Company or equal. Coat pipe and fittings inside and outside with the manufacturer’s standard coal tar enamel suitable for domestic water service. PVC AWWA C900 piping with solvent welded fittings can be used where acceptable by the local authorities.

3.05 STORM AND SANITARY DRAINAGE PIPING SYSTEMS

A. Soil, Waste, and Vent Piping Underground: Service weight cast iron soil pipe and fittings with lead and oakum joints or neoprene gasket joints made up with "Lubrifast" joining material or PVC piping with solvent welded joints. Provide and install code-approved manholes as required.

1. Grease waste piping and/or waste piping in commercial kitchen applications with water temperatures greater than 140°F shall be service weight cast iron or schedule 40 CPVC from floor drains, floor sinks, or hub drains to connection to grease trap or connection to civil sanitary piping. PVC piping is not permitted on waste or grease waste piping in commercial kitchen applications with water temperatures greater than 140°F.


C. Soil, Waste, and Vent Piping Above Ground: Schedule 40 PVC pipe with PVC drainage fittings. NOTE: Use PVC piping with solvent welded joints only where allowed by code. Piping shall be insulated with NetLag acoustic insulation on laterals over public spaces.

D. Storm Piping Above Ground: Same as Soil, Waste and Vent Piping Above Ground.

E. Pump Discharge Piping: Discharge from pumps to the horizontal gravity main shall be Schedule 40 galvanized steel with galvanized cast iron drainage fittings, or Schedule 40 PVC piping and fittings where code allows. Each pump discharge shall be carried separately to the horizontal gravity main and shall discharge into the top of the horizontal gravity main.

F. Cleanouts:
   1. General: Care shall be used when locating cleanouts. Wherever possible, do not place cleanouts in "finished" areas. All locations shall be approved by the Architect.
   2. Finished Floor: Jay R. Smith No. 4434, cast iron adjustable assembly with nickel bronze cover and tapered thread bronze plug. Provide clamping collar when installed in floors having waterproof membrane.
   3. Unfinished Areas: Jay R. Smith No. 4434 cleanout with cadmium-plated, cast iron plug.
   4. Walls: Jay R. Smith No. 4434, cast iron with nickel bronze, square, smooth, access cover, vandal-proof screws.
   5. Outside: Jay R. Smith No. 4434, non-slip, vandal-proof cover.
   6. Locations:
      a. At base of every drainage stack
      b. Maximum distance between cleanouts is 90 feet.
      c. At turns greater than 45 degrees.
      d. Other locations required by local code.

3.06 NATURAL GAS PIPING SYSTEM
A. **Code Compliance Products:** Comply with local utility company codes and AGA regulations which require the products used for gas piping work to be selected from lists in certain published standards or coded as indicated.

B. **Gas Piping:** Gas piping intended for operation at pressures of 5 psig or greater shall be ASTM A53, Schedule 40, black steel joined by Schedule 40, black welding fittings. Gas piping intended for operation at pressures less than 5 psig shall be ASTM A53, Schedule 40, black steel joined by Schedule 40, black welded fittings or Class 150 pounds, banded, black malleable iron, threaded fittings.

C. **Concealed Piping and Protection:** Gas piping run concealed in walls, chases, or above ceilings shall be installed as required by local codes and the serving utility company.

D. **Underground Piping:** Gas piping installed below grade shall be coated with Republic Steel Corporation (US) “X-Tru-Coat” high density polyethylene extruded coating, factory-applied with a fluid mastic to a minimum thickness of 0.040”. Field welds, joints, and fittings shall be protected with mastic undercoat and by wrapping at least two layers of “X-Tru-Tape” installed as instructed by manufacturer. Polyethylene piping and fittings may be used if approved by the local authorities.

### 3.07 CLEANING, FLUSHING, TESTING, AND INSPECTING

A. **Cleaning:** Clean exterior surfaces of installed piping systems and prepare surface for application of any required coatings.

B. **Flushing:** Flush piping systems with clean water prior to performing any required tests.

C. **Piping Tests:**
   1. **General:** Blank off equipment during tests. Perform tests before piping is enclosed in walls, floors, partitions or in any other way concealed from view. Tests may be performed in sections. Tests shall be witnessed by the General Contractor and local inspectors and the test results presented to the Engineer for acceptance and approval prior to concealing piping from view. Provide all necessary equipment for testing, including pumps and gauges. Note: All test results are to be submitted to the Engineer as specified in Section 22 01 00.
   2. **Domestic Water Systems:** Test hot and cold water systems hydrostatically to a pressure of 150 psig or 1-1/2 times working pressure, whichever is greater, for a period of 4 hours. Repair all leaks, replacing materials as necessary, and repeat tests until systems are proven tight.
   3. **Soil, Waste, and Vent Piping System:** Test soil, waste, and vent piping by plugging all openings and filling system to height required by City Plumbing Inspector, but not less than 10’. Inspect all joints for leaks, repair all leaks found, and retest until piping is demonstrated to be free from leaks. In addition to water test, apply peppermint or smoke tests, if required by local code. All underground main piping shall be inspected with a camera and the taped test results submitted to the Owner.
   4. **Storm Drainage Piping System:** Test storm drainage piping same as specified for Soil, Waste, and Vent Piping System.
   5. **Natural Gas Piping System:** Test natural gas piping with compressed air or nitrogen at 5 times service pressure but not less than 100 psig for 24 hours and in accordance with the requirements of the local codes and the serving utility company. Repair all leaks, replacing materials as necessary, and repeat test until systems are proven tight.
   6. **Disinfecting of Water Systems:** Disinfect as required by code. Where code does not dictate tests to be conducted, at a minimum disinfect the hot and cold water systems as follows: Fill systems with water solution containing 50 ppm available chlorine, allow to stand for 4 hours, opening and closing all valves several times during this
period; thoroughly flush; refill and place system in service; ensure a chlorine content of 2.5 ppm.

7. Cleaning and Adjusting: Thoroughly clean and disinfect all plumbing fixtures, including all exposed trim. Adjust all flush valves for proper flushing, but without excess use of water.

D. Inspecting: Visually inspect each run of each system for completion of joints, adequate hangers, supports, and inclusion of accessories.

END OF SECTION 22 10 00
SECTION 22 11 23
PLUMBING PUMPS

PART 1 - GENERAL

1.01 SUMMARY

A. The General Provisions, Supplemental General Provisions, section 23 01 00, Division 1 Specifications and Special Provisions apply to all Work specified in this Section.

B. This section describes the basic materials and installation methods for the plumbing pump system. Comply with other Division 23 sections and drawings as applicable. Refer to other divisions for coordination of work.

C. Furnish and install all components of the plumbing pump systems specified herein, as indicated on the drawings, and as required to provide complete and operating systems.

1.02 DESCRIPTION OF WORK

A. Work Included: Provide pumps as specified and indicated.

1.03 QUALITY ASSURANCE

A. Manufacturers: Provide products by one of the following:
   1. Hyfab
   2. Bell and Gossett, ITT Division
   3. Crane Company
   5. Weil Pump Company
   6. SyncroFlo, Inc.
   7. PACO Pumps
   8. Taco, Inc.
   10. Myers

B. Electrical Standards: Provide electric motors and products which have been listed and labeled by Underwriters' Laboratories, Inc. (UL) and comply with National Electrical Manufacturers' Association (NEMA) standards.

C. Certification, Pump Performance: Provide pumps whose performance, under specified conditions, is certified by the manufacturer.

PART 2 - PRODUCTS

2.01 DOMESTIC COLD WATER PUMPS AND CONTROLS

A. Provide a domestic water system consisting of a prefabricated, multi-pump, triplex water pressure booster system with factory pre-charged tank and controls. System shall be capable of automatically providing the required system pressure and flows. Pumps shall have a capacity to provide 120% of system-calculated demand. Provide piping to bypass the pumping system for maintenance and service.
B. Each vertical turbine pump shall have vibration isolating mounts and a reinforced flexible pipe connection on each pump discharge line and all bronze construction.

C. Each pump shall be driven by a drip-proof motor. Each pump motor shall meet NEMA standards and operate within the available service factor at any point on the pump capacity head curve. Each pump motor shall be of premium efficiency and sized at 50%-50%-50%.

D. System shall include a factory pre-charged tank with replaceable flexible membrane separating air and water. Vessel shall be ASME Code and N.B. stamped. System pressure shall be maintained by a pilot-operated diaphragm type, pressure regulating valve on each pump discharge line. Valve body shall be cast iron with epoxy-coated cover and brass or epoxy coated disc guide, disc retainer, and diagram washer. In addition, separate spring-loaded, non-slam type check valves shall be included. Waterside pipe connections to tank shall be between the discharge of the lead pump and its pressure-reducing valve to assure constant system pressure. Hydro-pneumatic tanks may be designed in the penthouse at Engineer's option.

E. Furnish a single enclosure combination power and control panel, of NEMA 1 construction. Enclosure shall be steel and finished with an oven-baked enamel. The panel shall include, for each pump, a fused disconnect switch with external operating handle, starter with 3-leg overload protection, running light, and multiple position motor control switch. It shall also house control components and include 115 volt control transformer with control power switch, indicating lights, relays, audiovisual alarm system, and other necessary controls. All of the above shall be internally pre-wired at the factory and tested in accordance with the provisions of the National Electric Code. Panel shall have the UL-listing mark for industrial control panels.

F. System shall include individual 4-1/2" ASA Grade A pressure gauges for pumps, indicating system and suction pressures, all flush-mounted in a gauge panel directly above the power and control panel, and necessary pressure and flow switches to properly control pump sequencing. Also included are pressure switches for abnormally low or high suction, and low and high system pressure to protect pumps and activate audiovisual alarm system, all with manual reset. Controls shall be supplied to manually alternate equal capacity pumps. Each pump casing or barrel shall be fitted with a separate pre-wired temperature probe and approved electric purge valve installed immediately upstream of the pump discharge. [Panel shall include pump cutoff and alarm system to shut down each pump and activate a bell and have provision for actuating a remote alarm under any of the following conditions:
1. Low discharge pressure,
2. Fire pump operation

G. The entire booster system shall be factory-prefabricated on a common structural steel stand with interconnecting piping and wiring complete and operationally tested prior to shipment. Complete package shall also include isolation valves on the suction and discharge of each pump. Galvanized steel suction and discharge pipe manifolds, as well as copper tubing with shutoff cocks for gauges and pressure switches, will be furnished assembled. The only field connections required will be system suction and discharge and power connection at the control panel.

H. The factory shall certify in writing that the water pressure booster system and its component parts have undergone a complete electric and hydraulic test prior to shipment. Test shall include a "System Operating Flow Test", from zero to 100% design flow rate under specified suction and net delivery pressure conditions.
I. The internal multistage pumping assemblies and pressure regulating valves shall be guaranteed for 5 years from date of shipment against defective material and workmanship. Motors shall also be guaranteed for 5 years from date of shipment against burnout from any cause when equipped with standard over temperature protection system and maintained according to factory installations. The water pressure booster system, as a whole, shall be guaranteed in writing by the manufacturer for a period of one year from date of shipment against defects in design, materials, or construction.

J. Start-up Service: A factory-trained representative shall be made available on the job site to check installation, start-up, and instruct operating personnel.

2.02 SUMP PUMPS

A. General: Sump pumps shall be of the type, capacity, duty, motor horsepower, and speed required by the application. Furnish grease-lubricated intermediate guide bearings for every 6' length of pump shaft.

B. Sumps and Covers: Sump pits shall be constructed under Division 3, "Concrete". This Contractor shall furnish and install a steel cover plate and ring for each sump pit. Cover plate shall have 1 1/2" x 1 1/2" x 1/4" structural steel angle reinforcement on the underside, gasketed gastight bolted manhole, and threaded or flanged vent connection. Furnish and install a gastight steel base plate equipped with a lantern ring shaft stuffing box and means for removing each of the pumps separately without removing the large gastight cover.

C. Controls: Provide a non-float type control with high water alarm contacts for each pump, with provisions for actuating a local and remote alarm in the Engineer's office. Alternator shall be as manufactured by Allen-Bradley or approved equal. Control panel shall be a factory-wired NEMA Type 1 enclosure and shall include a disconnect switch, alternator, FVNR starter with circuit breaker for each motor, control panel-mounted high level alarm bell, control power transformer with fused disconnect switch tapped from the line side of the pump disconnect switch and pump running lights. Alarm switch and all controls shall be rated for 120 volt, 60 Hz, alternating current. Pump motor and electrical controls, including switch and motor controller, shall be mounted on an integral steel frame 2' above the level of the floor on which pump is located. This will allow the pumps to operate during any emergency flooding. Upper shaft bearing shall be at least 6" above pit cover plate. The Contractor shall provide the necessary steel framework and supports for elevating the electrical equipment.

2.03 SUMBERGED SUMP PUMPS

A. General: Sump pumps shall be of the type, capacity, and duty required by the application. The pumps shall have a cast iron casing and shall be equipped with bronze impellers dynamically balanced for all hydraulic loads within the operating range of the pump. Tripod support shall be integrally cast with pump casing. The design of the pump shall permit removal of motor shaft/impeller assembly without the need to disconnect the discharge piping or remove the pump casing from the basin. Pumps shall be capable of handling drainage containing sand and a water temperature of 105°F.

B. Sumps and Covers: Sump pits shall be constructed under Division 3, "Concrete". This Contractor shall furnish and install a steel cover plate and ring for each sump pit. Cover plate shall have 1 1/2" x 1 1/2" x 1/4" structural steel angle reinforcement on the underside gasketed gastight, bolted manhole, and threaded or flanged vent connection.
C. Controls: Provide a float switch with gastight rubber bellows, bronze float and rods, alternator, high level automatic alarm switch with gastight rubber bellows, and provisions for activation of a local and remote alarm in the Engineer’s office. Control panel shall be a factory-wired NEMA Type 1 enclosure and shall include a disconnect switch, alternator, FVNR motor starter with circuit breaker, control panel-mounted high level alarm bell, control power transformer with fused disconnect switch tapped from the line side of the pump disconnect switch, and pump running lights. Alarm switch and all controls shall be rated for 120 volt, 60 Hz alternating current.

D. Motors: Motors shall be of the oil-filled, totally enclosed, immersible design. Each motor shall be of the ball-bearing type, equipped with a stainless steel shaft, expansion diaphragm, and a face-type seal on output shaft to seal motor from the liquid being pumped. Each motor shall be supplied with not less than 10’ of immersible unitized cable.

2.04 CIRCULATING PUMPS

A. General: In-line circulating pumps shall be stainless steel or bronze body construction of the size, type, and capacity required by the application. Pumps shall be fitted with a dynamically balanced, brass enclosed type impeller with mechanical seal. Motor shall have a maximum speed of 1750 rpm. Pumps, casings, flanges, and seals shall be suitable for operation with the working pressures and temperatures required and shall be listed for potable water usage. The working pressure applies to the entire pump assembly.

2.05 REMOTE ALARM ANNUNCIATION

A. General: The following alarms for the pumping systems are to be annunciated. If a Building Automation System is provided in the building, these alarms shall be integrated into the automation system.
   1. Domestic water pump shutdown for each individual pumping system
   2. Sump pump high level alarms for each sump pump
   3. Fire pump input power failure or circuit breaker in OPEN position for each fire pump
   4. Jockey pump input power failure for each jockey pump
   5. Boiler low water level alarm for each boiler

B. Labeling: Each alarm lamp shall be labeled with an engraved nameplate identifying the alarm indicated.

C. Power Source: The remote annunciator shall be served by a dedicated 120 volt emergency power branch circuit.

PART 3 - EXECUTION

3.01 INSPECTION

A. General: Installer shall examine the bases upon which and conditions under which pumps are to be installed and notify Contractor in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.02 PUMP INSTALLATION
A. General: Install pumps in accordance with manufacturer's written instructions and recognized industry practices to ensure that pumps comply with requirements and serve intended purposes. Comply with NEMA standards and requirements of NEC.

B. Alignment: Check alignment and, where necessary, realign shafts of motors and pumps within tolerances recommended by manufacturer.

C. Vibration Isolation: Install units on vibration mounts as required or specified. Comply with manufacturer's indicated installation method and with other applicable Sections of this Division.

3.03 ELECTRICAL CONNECTIONS

A. Grounding: Provide positive electrical pump and motor grounding in accordance with applicable requirements of the NEC.

3.04 QUALITY CONTROL

A. Field Test: Upon completion of pump installation and after motor has been energized from normal power source, bleed air from pump casing and test pump to demonstrate compliance with requirements. When possible, field-correct malfunctioning units then retest to demonstrate compliance. Replace units that cannot be satisfactorily corrected.

3.05 SUMP PUMPS

A. Construction Pumping: All construction drainage pumping shall be done with temporary equipment. After building is completely closed in and lower floors are broom clean and dry, the sumps shall be emptied and cleaned to the concrete surface of the bottom of the pit. At that time, permanent sump pumps shall be installed, lubricated, adjusted, checked, and placed in service.

B. Valves: Discharge check and gate valves shall not be smaller than the size of pump discharge.

END OF SECTION 22 11 23
SECTION 22 40 00
PLUMBING FIXTURES

PART 1 - GENERAL

1.01 SUMMARY

A. The General Provisions, Supplemental General Provisions, section 22 01 00, Division 1 Specifications and Special Provisions apply to all Work specified in this Section.

B. This section describes the basic materials and installation methods for plumbing fixtures. Comply with other Division 22 sections and drawings as applicable. Refer to other divisions for coordination of work.

C. Furnish and install all components of the plumbing fixtures specified herein, as indicated on the drawings, and as required to provide complete and operating systems.

1.02 DESCRIPTION OF WORK

A. Acceptable Manufacturers: The model numbers listed in the Specifications establish a level of quality and material. The following manufacturers are acceptable subject to compliance with the requirements of these Specifications. The guestrooms fixtures will be exactly as specified in Marriot standards. No substitutions will be allowed.

1. Fixtures
   a. American Standard
   b. Kohler Company
   c. Crane Company
   d. Toto
   e. Williams
   f. Oatey
   g. J. R. Smith Mfg. Co.
   h. Woodford

2. Faucets
   a. Chicago Faucet Company
   b. Speakman Company
   c. T & S Brass and Bronze Works, Inc.
   d. Delta

3. Flush Valves
   a. Sloan Valve Company
   b. Delany Flush Valves
   c. Zurn Industries, Inc.

4. Seats
   a. Church Products, Forbes-Wright Ind., Inc.
   b. Olsonite Corporation
   c. Beneke Corporation
   d. Bemis

5. Carriers
   a. Zurn Industries, Inc.
   c. Wade Div./Tyler Pipe

6. Drinking Fountains
   b. Elkay Mfg. Company
   c. Ebco/Oasis

7. Stainless Steel Sinks
PART 2 - PRODUCTS

See drawings for Fixture Schedule

PART 3 - EXECUTION

3.01 INSTALLATION

A. Heights: Set fixtures at heights as shown on the Architect's Drawings.

B. Caulking: This Contractor shall caulk the joint between the finished wall surface and all plumbing fixtures. Verify colors with the Architect. Caulking material shall comply with the appropriate section of these Specifications.

C. Emergency Eye Wash: Install an emergency eye wash in rooms where chemicals will be stored, in laundry room and in other locations as required by code or as indicated on the drawings. Pipe domestic cold water to eye wash.

D. Each fixture shall be provided with a shut-off valve for each supply line. All exposed lines shall be chromium-plated.

END OF SECTION 22 40 00
SECTION 23 01 00

GENERAL MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Division 23 includes Division 23 01 00 of the Specifications and Mechanical Drawings (HVAC). Elements of the Scope of Work include, but are not limited to, labor, materials, equipment, supplies, storage, transportation and all required permits, fees and licenses. Division 23 does not stand alone, but is part of the complete project and its Documents. Requirements of the General Conditions and Division 1 apply to all work in the Division.

B. Provide the necessary interface with other Divisions to provide a complete project. Carefully check the Documents of this Division with those Documents of other Divisions. Determine the requirements of any interfacing materials or equipment being furnished and/or installed by those Sections and Divisions, and provide proper installation and required interface.

C. No deviation from the Contract Documents shall be made without the written consent of the Architect and Engineer.

D. All Specifications and Drawings are to be considered together as the Contract Documents. Any work shown in one and not the other, or is implied by either, shall be provided to make a complete project. Should conflicts exist between the Specifications and Drawings or there is an item shown or noted for which is not clearly defined, immediately submit a request for clarification. Under no circumstance will conflicts between the Specifications and Drawings be grounds for additional cost to the Contract after the Contract is established.

E. The Drawings are schematic and are not intended to show the exact location of duct, piping, equipment, etc.

F. Dimensions and information regarding accurate locations of equipment, and structural limitations and finish shall be coordinated and verified with other Divisions of Work. Be prepared to furnish dimensions and information regarding the Work of this Division to other trades.

G. The right is reserved to relocate any device (receptacle, switch, fire alarm, audio/visual, junction box, outlet, etc.) a maximum of 10'-0" before it is permanently installed without incurring additional cost to the Contract.

1.02 REFERENCE STANDARDS

A. All work shall comply with the most recently revised versions of all local, state and federal codes, ordinances of the authority having jurisdiction, laws, rules and regulations. Any modifications required by any of the above shall be made without any additional cost to the Owner. Where requirements between governing Codes and Regulations vary, the more restrictive provision shall apply.

B. Nothing contained in the Contract Documents shall be construed as authority or permission to disregard legal requirements and regulations. The Contractor shall thoroughly review the Documents and bring any such conflicts to the attention of the Architect and Engineer prior to Installation.
C. All materials, installation, and workmanship shall comply standards and/or codes of the following:
2. International Mechanical Code - 2012 edition, with latest Georgia amendments
8. National Fire Protection Association
10. ANSI - American National Standards Institute
11. ASTM - American Society of Testing and Materials
12. NEMA - National Electrical Manufacturer's Association
13. OSHA - Occupational Safety and Health Act
14. UL - Underwriter’s Laboratories
15. ASHRAE - American Society of Heating and Air Conditioning Engineers
16. SMACNA - Sheet Metal and Air Conditioning Contractors’ Nat’l Assoc.

D. All materials shall be new and shall bear the label of UL.

1.03 DEFINITIONS

A. Provide: to furnish, install and connect.

B. Furnish: to supply all materials, labor, equipment, testing apparatus, controls, tests, accessories and all other items customarily required for the proper and complete application.

C. Install: to join, unite, fasten, link, attach, set-up or connect together, complete, tested, and ready for normal satisfactory operation.

D. Engineer: the Engineer of record.

E. Contract Documents: the complete set of Specifications and Drawings of all Divisions.

F. Work: labor, materials, equipment, accessories, controls and other items required for a complete installation.

G. Concealed: embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces or in enclosures.

H. Exposed: not installed underground or concealed.

I. Equal: equal in quality, workmanship, materials, weight, size, design and efficiency of the specified product, conforming with manufacturers.

J. Supply: to purchase, procure, acquire and deliver complete with related accessories.

K. Authority Having Jurisdiction (AHJ): applicable local, state and federal authorities having jurisdiction over any part of the Scope within this Division and other Divisions.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
A. Manufacturer’s names and catalog numbers specified in the Contract Documents are intended to describe the material and set the standard of quality. All bids shall be based on material specified. Request for approval of material not specified shall be considered if the request is in written form and submitted to the Architect no later than fourteen (14) days prior to the bid date. All requests shall conform to the provisions of the general and supplementary conditions.

B. When specific names are not stated, only the best available quality of material or equipment shall be submitted for review and used in the installation.

2.02 BASIS OF DESIGN

A. Where a product is designated as "BASIS OF DESIGN", the Contractor is notified that mechanical, electrical, structural, architectural, space conditions and/or other features of the overall project design have been based on the requirements of the "BASIS OF DESIGN" product.

B. Where a product is substituted for a "BASIS OF DESIGN" product, the Contractor is notified that changes in project design may be mandatory in order to permit use and installation of the substitute product. Shop drawing submittal for a substitute product shall include a complete schedule of changes in project design, if any, which must be made in order to permit use and installation of the substitute product. The Contractor shall bear all expenses related to the use of a substitute product.

2.03 SHOP DRAWINGS AND PRODUCT DATA

Refer to SRSS Section 01 33 00.

2.04 AS-BUILT DRAWINGS

Refer to SRSSA section 01 78 39 - Project Record Documents.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The equipment selections used in the preparation of the Contract Documents will fit into the physical spaces provided and indicated, allowing ample room for access, servicing, removal and replacement of parts, etc. Adequate space shall be allowed for clearance in accordance with the Code requirements and the requirements of the local Authorities having jurisdiction, and the equipment manufacturer's recommendations.

B. In the preparation of Drawings, a reasonable effort to accommodate acceptable equipment manufacturer's space requirements has been made. However, since space requirements and equipment arrangement vary according to each manufacturer, the responsibility for initial access, maintenance access, code required access, and proper fit rests with the Contractor.

C. Physical dimensions and arrangements of equipment to be installed shall be subject to the Architect’s and Engineer’s review.

D. The General Contractor and all Subcontractors shall coordinate the installation of ductwork, conduit, busway, piping, cable trays, etc., installation with lighting fixtures, special ceiling construction, air distribution equipment, and the structure. Provide additional rises, drops and offsets as required. If after installed, new ductwork, conduit, busway, piping or cable is found to be in conflict with the architecture, structure, or other
trade Work which is either existing or shown on the Contract Documents, the ductwork, conduit, busway, piping or cable shall be relocated without additional cost to the Owner.

E. No ductwork, piping, equipment, etc., shall be installed in the eight (8) inch high zone directly above the ceiling in tenant areas to allow for tenant build-out and flexibility unless otherwise specifically shown on the Drawings or prior written authorization is received from the Engineer.

F. Accessibility and Clearance:
   1. Mechanical equipment, ductwork, piping, etc. shall be installed in accessible locations, avoiding obstructions, preserving headroom, and keeping openings and passageways clear.
   2. Minor adjustments in the locations of equipment shall be made where necessary, providing such adjustments do not adversely affect functioning of the equipment.

G. Scaffolds and staging for installation of mechanical work shall be provided under the work of this Division.

3.02 STRUCTURAL FITTINGS

A. Furnish and install the necessary sleeves, inserts, hangers, anchor bolts, and related structural items. Install at the proper time.

B. Openings may have been indicated on the Architectural and Structural drawings. Should any additional openings or holes be required, the same shall be provided at no additional cost to the Owner.

C. Location: At a time in advance of the work, verify openings shown on the Architectural and Structural drawings, and coordinate any additional openings.

D. If the work of this Section requires modification of the Architectural or Structural drawings, furnish new instructions as to requirements for these openings. Submit for review and coordination to Architect.

E. Sleeves shall be supplied for mechanical piping passing through walls or slabs and shall be placed before concrete is poured.

F. Equipment supports for mechanical work shall be fastened to the structure by inserts, anchor bolts, bolting to drilled and tapped structural members, or be welded to the structure.
   1. Welding shall be done by the electric arc method with fully competent welders. Supporting members shall be shop coated with a suitable primer.
   2. Surfaces damaged by installation of supports shall be touched up with primer to match shop coat. Any drilling of structural members shall be approved by the Architect.

G. Flashing:
   1. Wherever ductwork and/or piping pass through the roof or outer walls, base flashing and counter-flashing shall be provided.
   2. Such flashing shall be properly installed by skilled workmen, and shall include grouting, mastic or tar application, or other means to insure a permanent, waterproof, neat and workmanlike installation.
   3. Insofar as possible, flashing shall comply with and be similar to requirements for flashing in General Construction Work.

H. Anchor bolts and inserts shall be galvanized and of adequate size and strength for installation of electrical work and shall be placed in forms before concrete is poured.
1. Placement of bolts in bases shall be done under other Division. Furnish detail drawings, templates, and anchor bolts for bases to the General Contractor in time to avoid delaying work schedules.

2. Expansion shields shall only be used with specific approval of the Architect. Wooden or soft metal plugs shall not be used.

I. Cutting and patching:
   1. All additional cutting, patching and reinforcement of construction of building, subject to review by the Architect, shall be performed under this Section.
   2. Refer to appropriate Division for requirements.

3.03 WEATHERPROOF EQUIPMENT

A. Mechanical devices or equipment located in damp, semi-exposed areas shall be weather-resistant. Enclosures shall comply with NEMA Type 3R requirements.

B. Air distribution devices located in damp areas outside shall be weather-resistant (aluminum, etc.).

3.04 CLEANING

A. Brush and clean work prior to concealing, painting and acceptance. Perform in stages if directed.

B. Painted exposed work soiled or damaged: Clean and repair to match adjoining work before final acceptance.

C. Remove dust and debris from inside and outside of material and equipment.

3.05 TESTS AND DEMONSTRATIONS

A. All systems shall be tested in the presence of the Owner or an Owner designated representative upon completion of the Work and demonstrates that the installation is in accordance with the Contract Documents.

B. All motors shall be checked and adjusted for correct direction of rotation.

C. Any work found not to be in compliance with the Contract documents shall be repaired or replaced without incurring additional cost to the Contract price.

D. Provide all instruction to the Owner on maintenance and operation of all systems and equipment provided under this Division.

3.06 WARRANTIES

A. The warranty period for all systems, equipment, components, work, etc. shall be no less than one (1) year, unless specified otherwise hereinafter and shall include at least one (1) full heating season and one (1) full cooling season. The warranty shall include parts and labor.

B. The Contractor shall, without cost to the Owner, remedy any defects within a reasonable time to be specified in notice from the Architect. In default thereof, the Owner may have such work done and charge all costs to the Contractor.
C. The start of the Contractor’s warranty period, as defined in the General Conditions, shall commence on the issue of a “Certificate of Substantial Completion”, by the Owner or the Owner’s Representative for each item of material, equipment or system.

D. The Subcontractor shall confer with the General Contractor prior to the bid date concerning the project schedule and determine if there is a need to operate any items of equipment or systems for temporary heating and/or cooling or other reasons prior to “Substantial Completion”. All required extended warranty costs for equipment, materials, and systems shall be included in the Subcontractor’s bid.

END OF SECTION 23 01 00
SECTION 23 05 29
HANGERS & SUPPORTS FOR HVAC
PIPING & EQUIPMENT

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. The Conditions of the Contract and applicable requirements of Division 1, “General Requirements”, and Section 23 01 00 “General Mechanical Requirements”, govern this Section.

1.02 DESCRIPTION OF WORK

A. Work Included: Provide pipe hangers, supports, and required appurtenances as specified and indicated

1.03 QUALITY ASSURANCE

A. MSS Standard Compliance: Provide pipe hangers and supports of materials, design, and manufacture which comply with ANSI/MSS SP-58, SP-59, SP-89, and SP-90.

B. Acceptable Manufacturers: The model numbers listed in the Specification establish a level of quality and material. Subject to compliance with requirements, provide products and materials by the following:
   1. ITT Grinnell Corporation,
   2. Fee and Mason,
   3. Central Iron Manufacturing Company, and
   4. F & S Manufacturing Company
   5. Anvil International
   6. B-Line

PART 2 – PRODUCTS

2.01 PIPE HANGERS AND SUPPORTS:

A. General: Provide pipe hangers and supports as specified. Comply with local codes and standards for pipe and equipment support and anchorage. Pipe supports shall be of material that will prevent electrolytic action.


C. Piping in Multiple Parallel Runs: Provide Grinnell No. 45 or No. 50 with Grinnell No. 137 U-bolt pipe clamps or structural channels or angles with U-bolt clamps, supported as trapeze hangers where multiple parallel runs of piping are shown. Select and size members for weights to be carried and span dimensions between supports.

D. Piping in Single Runs: Provide Fee and Mason Fig. 239 or Grinnell No. 260 clevis hanger.

E. Hanger Rod: Provide hanger rods of required length. Rod diameters shall be as listed in the following table. Rod diameters may be adjusted after consultation with the Structural
Engineer concerning the building framing system, the method of attachment to the structure and the support rod spacing.

<table>
<thead>
<tr>
<th>Pipe Sizes</th>
<th>Rod Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4&quot; - 2&quot;</td>
<td>3/8&quot;</td>
</tr>
<tr>
<td>2-1/2&quot; – 3</td>
<td>1/2&quot;</td>
</tr>
<tr>
<td>4&quot; – 5</td>
<td>5/8&quot;</td>
</tr>
<tr>
<td>6&quot;</td>
<td>3/4&quot;</td>
</tr>
<tr>
<td>8&quot; – 12&quot;</td>
<td>7/8&quot;</td>
</tr>
<tr>
<td>14&quot; – 18&quot;</td>
<td>1&quot;</td>
</tr>
</tbody>
</table>

F. Riser Clamps: Provide Fee and Mason Figure 241 riser clamps. Riser clamps for copper tube shall be copper-plated.

G. Saddles and Shields:
1. Saddles for Horizontal Insulated Piping Without Vapor Barrier: At each hanger or support on horizontal runs, provide Grinnell No. 160 or Fee and Mason Figure 171, 1710, 1712, or 172 saddles, as applicable. Shields as described below may be used instead of the saddles. On heating water systems below 140°F (60°C), hangers may be sized for the pipe size and of a material compatible with the pipe. Where dissimilar materials are used, provide dielectric separation. Carry insulation over the hanger and seal where hanger is sized for pipe.
2. Shields for Horizontal Insulated Water Piping with Vapor Barrier: At each hanger or support for water piping, provide a half section of preformed 6 PCF density fiberglass or rigid calcium silicate, with jacket of adjacent insulation brought across unbroken, supported on semicircular 16 gauge shields. Shields for pipe 4" and smaller shall be 12" long; shields for pipe 5" to 8" shall be 18" long; and shields for larger pipe shall be 24" long.

H. Piping on Roof: Roof mounted pipe supports are discouraged. If roof supports are necessary, installation methods must be approved by the architect, engineer, general contractor and the Roofing Contractor.

PART 2 – EXECUTION

3.01 INSTALLATION:

A. Independent Support: Support fire sprinkler and standpipe piping independently of other piping in accordance with NFPA-approved methods and local codes and standards.

B. Provisions for Movement:
1. Movement: Install hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate the action of expansion joints, expansion loops, expansion bends, and similar units.
2. Load Distribution: Install hangers and supports so piping live and dead loading stresses from movement will not be transmitted to any pipe or connected equipment. Pipe supports shall properly transmit the weight of the pipe and its contents to the building structure, or to independent posts, piers, or foundations.
3. Pipe Slopes: Install hangers and supports to provide the indicated pipe slopes so maximum pipe deflections allowed by ANSI B31 are not exceeded.

C. Insulated Piping: Comply with the following installation requirements:
1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through the insulation; do not exceed pipe stresses allowed by ANSI B31.
2. Shields: Where low-compressive-strength insulation of vapor barriers are indicated on cold, chilled, or heating water piping, install coated protective shields. For pipe 8” and over, install rigid calcium silicate insulation between saddles and pipe.

D. Spacing: Install hangers and supports in piping systems to remove stress from equipment flanges and rotating equipment. Space hangers and supports as shown in the following table. Rod spacing may be adjusted after consultation with the Structural Engineer concerning the building framing system, the method of attachment to the structure and the support rod diameters.

<table>
<thead>
<tr>
<th>Trade Pipe Size</th>
<th>Maximum Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2”</td>
<td>5'</td>
</tr>
<tr>
<td>3/4”</td>
<td>6'</td>
</tr>
<tr>
<td>1” and 1-1/4”</td>
<td>7'</td>
</tr>
<tr>
<td>1-1/2”</td>
<td>9’</td>
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<tr>
<td>2”</td>
<td>10’</td>
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<tr>
<td>2-1/2”</td>
<td>11’</td>
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<tr>
<td>3”</td>
<td>12’</td>
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<tr>
<td>4”</td>
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<td>5”</td>
<td>16’</td>
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<td>6”</td>
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<td>14”</td>
<td>25’</td>
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<tr>
<td>16”</td>
<td>27’</td>
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<tr>
<td>18”</td>
<td>28’</td>
</tr>
</tbody>
</table>

E. Saddles: Where insulation without vapor barrier is indicated, install protection saddles, or use hangers as indicated in Paragraph 2.0/H.1.

F. Guides: Install pipe guides complying with the manufacturer’s published product literature. Where not otherwise indicated, install pipe guides near expansion loops, expansion joints, and ball joints.

G. Anchors: Install anchors at the proper locations to prevent stresses from exceeding those permitted by ANSI B31 and to prevent the transfer of loading and stresses to connected equipment. Anchors shall include vibration isolation in accordance with the pipe support system specified. Where the piping system is floating, the anchors shall be termed restraints or braces.

1. Where expansion compensators are indicated, install anchors in accordance with the expansion unit manufacturers written instructions, to limit movement of piping and forces to the maximums recommended by the manufacturer of each unit.
2. Where not otherwise indicated, install anchors at the ends of principal pipe runs and at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required accommodating both expansion and contraction of piping.

H. Leveling: Adjust hangers and supports and place grout as required under supports to bring piping to proper levels and elevations.

I. Hangers: Refer to Section 23 05 48, “Vibration Isolation”, for additional information and support requirements. Pipe hangers made of wood, wire, or sheet iron shall not be permitted.
J. Riser Supports: Vertical piping shall be secured at sufficiently close intervals to keep the pipe in alignment and carry the weight of the pipe and contents.

1. Cast iron soil pipe shall be supported at the base and at each story level, but in no case at intervals greater than 10’.
2. Steel pipe shall be supported at the base and at no less than every other story level, but in no case at intervals greater than 25’.
3. Copper tube shall be supported at each story level, but in no case at intervals greater than 10’.
4. Plastic pipe shall be supported at mid point between floors and at ceiling to prevent movement, but in no case at intervals greater than 8’.

END OF SECTION 23 05 29
SECTION 23 05 48

VIBRATION ISOLATION

PART 1 - GENERAL

1.01 SUMMARY

A. The General Provisions, Supplemental General Provisions, section 23 01 00, Division 1 Specifications and Special Provisions apply to all Work specified in this Section.

B. This section describes the basic materials and installation methods for the vibration isolation systems. Comply with other Division 23 sections and drawings as applicable. Refer to other divisions for coordination of work.

C. Furnish and install all components of the vibration isolation systems specified herein, as indicated on the drawings, and as required to provide complete and operating systems.

1.02 DESCRIPTION OF WORK

A. Work Included: Provide vibration isolation work as specified and indicated, including the following:
   1. Support isolation for motor-driven mechanical equipment
   2. Inertia base frames in conjunction with equipment isolation
   3. Support isolation of air-handling housings
   4. Isolation including support isolation for piping risers
   5. Support isolation of piping
   6. Flexible ductwork connections

1.03 QUALITY ASSURANCE

A. General: Except as otherwise indicated, obtain support isolation units from a single manufacturer.

B. Supervision: Manufacturer shall provide technical supervision of the installation of support isolation units produced by him and of associated inertia bases.

C. Manufacturers: Provide vibration isolation support units manufactured by one of the following or an approved equal: Amber-Booth, Vibrations Mounting and Controls, Inc., Korfund Dynamics Corporation, Consolidated Kinetics Corporation.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Suspended Fans: Isolate with not less than four combination spring and rubber-in-shear vibration isolators.

B. Fluid Cooler Mounted on Ground: System is internally isolated; no special vibration isolation is required.

C. Suspended Fan & Coil Unit: Isolate with not less than four combination spring and rubber “in-shear” vibration isolators.

D. Flexible Pipe Connections at Rotating Equipment: Isolate supply and return piping to each pump with braided metal hose connectors between pump and valve.
E. Flexible Ductwork Connections to Equipment: Install flexible connections between sheet metal ductwork and equipment or fan collar. Locate as close to fan as possible. Isolate the duct system from the equipment by at least 1”.

F. Roof Mounted Air Handling Units: Provide housed spring type isolators with vertical limit stops. Provide with 1” deflection (0 to 500 rpm) or .75” deflection (501 and over rpm).

PART 3 - EXECUTION

3.01 ISOLATOR PERFORMANCE

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

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

3.02 RELATED WORK EXAMINATION

A. Examination and Reporting: Installer of vibration isolation work shall observe the installation of other work related to and connected to vibration isolation work. After completion of other related work (but before equipment start-up), installer shall furnish a written report to the Contractor, with a copy to the Engineer, listing observed inadequacies for proper operation and performance of vibration isolation work.

B. Correction and Start-up: Do not start-up equipment until inadequacies have been corrected in a manner acceptable to the vibration isolation Installer.

3.03 EQUAL LOADING

A. General: Equipment installed on vibration isolating mountings shall be level after load is applied. Further vibration isolating mountings shall be selected and installed to compensate for unequal loading. Spring isolators with coils touching during equipment start-up or operation will not be acceptable.

END OF SECTION 23 05 48
PART 1 - GENERAL

1.01 SUMMARY

A. The General Provisions, Supplemental General Provisions, section 23 01 00, Division 1 Specifications and Special Provisions apply to all Work specified in this Section.

B. This section describes the basic materials and installation methods for the identification of equipment and piping. Comply with other Division 23 sections and drawings as applicable. Refer to other divisions for coordination of work.

C. Furnish and install all components of the identification of equipment and piping specified herein and/or as indicated on the drawings.

1.02 DESCRIPTION OF WORK

A. Work Included: Identification of mechanical equipment shall consist of equipment labeling, pipe marking, and valve tagging as specified hereinafter.

1. In general, all equipment shall be labeled. This shall include all central plant, air handling or air conditioning equipment, and other similar and miscellaneous equipment.

2. Pipe markings shall be applied to all piping.

3. Each valve shall be identified with a stamped tag. Valves and tagging shall be scheduled typewritten on 8 ½” x 11” paper, tabulating valve number, piping system, system abbreviation, location of valve (Room or area), and service (e.g. – 2nd Floor North Domestic Hot Water). The valve schedule shall be submitted to the Engineer for approval prior to ordering or installing valve tags. See Section 23 01 00, “General Mechanical Requirements” for information and requirements regarding Operation and Maintenance Manuals.

Labels, tags, and markers shall comply with ANSI A13.1 and other applicable state and local standards for lettering size, colors, and length of color field.

4. Equipment and device identification specified in other sections shall be provided as a part of those requirements.

1.03 ACCEPTABLE MANUFACTURERS

A. Labels, markings, and tags shall be manufactured by W.H. Brady, Seton, Allen, or Industrial Safety Supply.

PART 2 - PRODUCTS

2.01 EQUIPMENT LABELING

A. Equipment labeling shall be one of the following, unless noted or specified otherwise:
1. Permanently attached engraved brass or plastic laminated signs with 1” high lettering. Signs on exterior equipment shall be brass.
2. Stencil painted identification, 2” high letters, with standard fiberboard stencils and standard black (or other appropriate color) exterior stencil enamel.

2.02 PIPE MARKINGS

A. On piping less than 6” diameter, install plastic semi-rigid snap-on type, manufacturer’s standard pre-printed color-coded pipe markers extending fully around the pipe and insulation or pressure-sensitive vinyl pipe markers similar to the above. Pipe markings can also be applied with the stick type backing in lieu of the semi-rigid snap-on-type.

B. On piping and insulation 6” and greater diameter, full band as specified above or strip-type markers fastened to the pipe or insulation with laminated or bonded application or by color-coded plastic tape not less than 1 ½” wide, full circle at both ends of the marker. Pipe markings can also be applied with the stick type backing in lieu of the semi-rigid snap-on-type.

C. Arrows for direction of flow provided integral with the pipe marker or separate at each marker.

2.03 VALVE TAGS

A. Valve tags shall be polished brass or plastic laminate with solid brass S hook and chain. Tags shall be stamped or engraved with the appropriate abbreviation for the type of service (e.g. – CW, HW, HWR), as well as the designated valve number.

B. A valve schedule is to be provided to the Owner. For each page of valve schedules, a glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.

PART 3 - EXECUTION

3.01 GENERAL

A. Identification labeling, marking, and tagging shall be applied after insulation and painting has been completed.

B. Coordinate names, abbreviations, and other designations used in mechanical identification work with corresponding designations shown, specified, or scheduled on drawings. Prior to ordering any labels, markings, or tags, obtain the approval of the Engineer regarding names, abbreviations, etc.

C. The Plumbing, HVAC, and Fire Protection Contractors shall coordinate labeling, marking, and tagging to ensure consistent and coordinated identification. In existing buildings, utilize similar names, abbreviations, and other designations that are currently in use to remain consistent with existing identification.
D. Equipment labeling shall consist of unit designation as shown on the drawings. Exhaust fan labeling shall also indicate service or the room or area of service.

E. Pipe and ductwork markers shall be placed on piping and ductwork on 25' centers in mechanical rooms and concealed spaces. In locations where piping and ductwork is exposed, place markers on 50' centers. Flow directional arrows should be marked on the piping at taps from the main and riser.

F. Valve tags shall be placed on each valve except those intended for isolation of individual heat pumps or terminal units (e.g. - VAV boxes, fan coil units, unit heaters, etc.). Valve tag schedules shall be prepared as specified hereinbefore. Copies of one schedule shall be laminated in clear plastic and placed where directed by the Owner. Other sets shall be included in the Operating and Maintenance Manuals.

END OF SECTION 23 05 53
SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.01 SUMMARY

A. The General Provisions, Supplemental General Provisions, section 23 01 00, Division 1 Specifications and Special Provisions apply to all Work specified in this Section.

B. This section describes the basic materials and installation methods for the testing, adjusting, and balancing of HVAC systems. Comply with other Division 23 sections and drawings as applicable. Refer to other divisions for coordination of work.

C. Provide testing, adjusting, and balancing specified herein, as indicated on the drawings, and as required to provide complete and operating systems.

1.02 DESCRIPTION OF WORK

A. Work Included:
   1. All air and water systems shall be tested, adjusted, and balanced to optimize operating and comfort conditions. Record test data as outlined hereinafter and submit for review and approval. Systems shall be fully tested and balanced prior to Building commissioning and acceptance.
   2. Conduct tests as specified herein, and as required by authorities having jurisdiction, including Local Inspection Department or Construction Manger.
   3. Repair or replace defects discovered or resulting from the required tests to a like new condition.
   4. All tenant finish air balancing will be by the tenant finish contractor. All air and water moving equipment installed under the shell building contracts will be balanced by the shell contractor.
   5. This is a LEED certified building which will require the IAQA flush out per USGBC standards. Contractor shall be responsible for performing the flush out and scheduling the necessary amount of time required to avoid delay of occupancy.

1.03 QUALITY ASSURANCE

A. Personnel: Submit evidence to show that the personnel who will actually balance the systems are qualified. Evidence showing that the personnel have passed the tests required by the Associated Air Balance Council (AABC) or the National Environmental Balancing Bureau (NEBB) will be sufficient.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

3.01 TEST DATA

A. General: Record test data after balancing has been completed and deliver recorded data to the Engineer for review and evaluation. Should deficiencies or discrepancies be found, repeat balancing procedures to achieve correct test data results. Certify the test
and balancing data as being true and correct over the Contractor's signature. Execute
the Certification by an authorized officer if the contracting firm is a corporation, by a
partner if the firm is a partnership, by the firm's owner if the firm is a sole proprietorship,
or by the authorized representative if the firm is a joint venture. Include a copy of the
approved test and balancing data in the Owner's Manual.

B. Test Forms: Record and submit test and balancing data on forms similar to those of the
AABC or NEBB.

3.02 CALIBRATION TEST

A. Submit evidence to show that the balancing devices are properly calibrated before
proceeding with system balancing.

3.03 PRELIMINARY AIR TESTING

A. General: Preliminary air tests shall be performed before duct work or equipment is
enclosed in walls, floors, ceilings, chases, or in any other way concealed from view.
Tests may be conducted on individual systems. Submit notification when systems are
ready for preliminary air tests. Condenser water shall not be required for preliminary air
tests. Make necessary arrangements to energize fan motors for the tests. Where
possible, conduct the tests before the application of exterior duct insulation and
installation of grilles or diffusers. Remove section of duct to allow design airflow at
design static pressure where necessary.

B. Tests: Demonstrate that there is no excessive leakage of the duct work by visual
inspection, that fans are operating at essentially the correct speed, that motors will not
overload, and that equipment delivers design cfm. Correct any deficiencies found.
Repeat preliminary air tests until tests have proven satisfactory.

C. Inspection: Inspection and acceptance of the Work shall, in addition to the foregoing
requirements, be subject to the following conditions:
1. Instruments: Test instruments, devices, and similar items, their accuracy and the
methods by which instruments are employed, shall be approved by AABC or NEBB
for use at the job site.

3.04 FINAL AIR BALANCE

A. General: When tests have been completed and systems are complete and ready for
operation, perform the following steps of final air balance and record the results.

B. Motors: Verify correct rotation of rotating equipment. Verify that properly sized thermal
heater elements are installed in starters. Verify that properly sized duel-element fuses,
where specified, are installed in disconnect switches.

C. Filters: Check air filters or filter media. Balance system only with clean filters or filter
media.

D. Airflow at Each Unit: Read and record return and/or outside air, supply air cfm, and
temperature at each fan and blower.

E. Water flow at Each Unit: Set thermostat for full cooling and for full heating loads.
Measure and record supply and return water flow at each cooling/heating coil.

F. Coil Temperatures: Set thermostat for full cooling and for full heating loads. Read and
record entering and leaving dry bulb and wet bulb temperatures at each cooling and
heating coil.
G. Outlet Airflow: Adjust each air exhaust inlet and supply diffuser, register, and grille to within 10% of design air cfm. Dampers in diffusers (if specified) may be used for only 10% adjustment from full open airflow. Include terminal points of air supply and points of exhaust.

END OF SECTION 23 05 93
PART 1 - GENERAL

1.01 SUMMARY

A. The General Provisions, Supplemental General Provisions, section 23 01 00, Division 1 Specifications and Special Provisions apply to all Work specified in this Section.

B. This section describes the basic materials and installation methods for the insulation of HVAC and Plumbing piping, duct, and equipment. Comply with other Division 23 sections and drawings as applicable. Refer to other divisions for coordination of work.

C. Furnish and install all components of the insulation system specified herein, as indicated on the drawings, and as required to provide complete and operating systems.

D. All adhesives, mastics, glues, sealants, etc… shall meet the LEED requirements.

1.02 QUALITY ASSURANCE

A. Manufacturer: Approved manufacturers are Armstrong, Calsite, Cell-U-Foarm Corp, Ceelco, Certainteed Corp, Dow Chemical Company, Forrest Mfg Co, Foster / Chilers, Gemco, Johns Manville, Knauf Fiberglass, Midwest Fastners, Owens Corning Fiberglass, Pittsburg Corning Fiberglass, Rubatex, Trymer, and Venture Tape.

B. All insulation, jacket and adhesive shall have a fire and smoke hazard ratings as tested under ASTM E 84, NFPA 255, and UL 723 not exceeding:

- Flame Spread: 25
- Fuel Contributed: 50
- Smoke Developed: 50

Exceptions: Type B Insulation and PVC Fitting Covers

1.03 SUBMITTALS

A. Per Section 23 01 00.

B. Product Data
   1. Type A Insulation
   2. Type B Insulation
   3. Type C Insulation
   4. Type E Insulation
   5. Type F Insulation
   6. Type G Insulation
   7. Vinyl Lacquer Paint for Type B Insulation
   8. Metal Jacket

1.04 DEFINITIONS

A. The phrase "Storm Drainage Conductor" refers to that portion of the storm drain interior to the building, between the roof drain body and where the pipe goes below grade.
B. The word “plenum” shall mean a ceiling space or mechanical room used for the transfer of conditioned return and/or outside air.

PART 2 - PRODUCTS

2.01 PIPING INSULATION

A. Type A – Fiberglass (indoor)
   1. One Piece glass fiber, rigid molded sectional pipe covering with factory applied aluminum foil and white craft paper flame retardant vapor barrier jacket, conforming to ASTM C547, Class II, Mineral Fiber Preformed Pipe Insulation.
   2. Thermal Conductivity (k) equals approximately 0.23 (BTU/HR., SF., Degree F, IN) at 75 °F.
   3. Similar to Johns Manville Corp “Micro Lox 650 AP T”, or approved equal.

B. Type B - Closed Cell (indoor)
   1. Closed cell, flexible foamed plastic conforming to ASTM C534, "Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form." Insulation shall be suitable for a temperature range from –40 degrees F to 220 degrees F.
   2. Conductivity (k) equals approximately 0.27 (BTUHR., SF., Degree F, IN) at 75 °F.
   3. Similar to Armstrong “Armaflex”, or approved equal.

C. Type C – Polyisocyanurate (outdoor)
   1. Prefabricated 2 lb./cu.ft. density polyisocyanurate insulation with waterproof mastic and glass fiber jacket finished with an aluminum jacket with waterproof silicone caulk joints.
   2. Conductivity (k) equals approximately 0.14 (BTU IN/HR., SF., degree F) per inch thickness at 200 °F.
   3. Insulation shall be applied per manufacturer’s recommendations. Joint sealants and coatings shall be as approved by the insulation manufacturer for the intended application and service temperature range.
   4. Jacketing shall be an all service jacket with 1 mm aluminum foil on pipe insulation and FSK jacket on board stock applied by the manufacturer to ASTMC-1136. Jacket shall have integral flap for sealing joint.
   5. Similar to Trymer 9501, or approved equal.

2.02 EQUIPMENT INSULATION

A. Type E
   1. Calcium silicate block conforming to ASTM C 553, Type I (1200 degrees F. max), asbestos free.
   2. Conductivity (k) equals approximately 0.42 (BTU/HR., SF., degrees F, IN) at 75 °F.
   3. Similar to Calsilite, or approved equal.

2.03 DUCTWORK INSULATION

A. Type F – Duct Wrap
   1. Duct insulation shall be 2" thick, minimum 3/4 lb. density fiberglass with an FSKL aluminum foil jacket, reinforced with fiberglass scrim.
   2. Conductivity (k) equals approximately 0.24 (BTUHR., SF., degrees F, IN) at 75 °F.
   3. Integral UL rated vapor barrier of:
      a. Aluminum foil reinforced with fiberglass scrim laminated to 30-lb. kraft paper.
      b. Class I white vinyl 0.004 inch thick, where specified.
   4. Similar to Johns Manville Corp “Microlite”, or approved equal.

B. Type G - Duct Liner
1. ASTM C1071, Type II, Grade 2, R-6, 1" thickness, 1.5 lb. Density for low pressure ductwork and 3.0 lb density for medium pressure ductwork, bonded mat of glass fiber coated with black fire resistant and microbial resistant coating, complying with TIMS AHC 101. Moisture adsorption shall not be greater than 0.5% moisture by volume when exposed to moisture-laden air at 120°F and 96% RH, per ASTM C553. Insulation shall be Schuller “Permacote Linacoustic” R-300, "Aeroflex Ductliner" as manufactured by Owens Corning Fiberglass Corp. or "Ultralite with Certa Edge" by Certainteed Corp. or equal by Knauf Fiberglass.
2. Duct liner adhesive shall comply with ASTM C916 "Specifications for Adhesives for Duct Thermal Insulation".
3. Liner Fasteners: Mechanical or weld secured fasteners for duct liner where finish of duct is not exposed. For exposed ductwork, except in mechanical rooms, provide adhesively secured fasteners. Position fasteners are recommended by SMACNA.
4. Minimum Sound Absorption coefficients shall be:

<table>
<thead>
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<th>Frequency (Hz)</th>
<th>Coefficient</th>
<th>Attenuation*</th>
</tr>
</thead>
<tbody>
<tr>
<td>125</td>
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<tr>
<td>4000</td>
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</tr>
</tbody>
</table>

* Attenuation in dB per 10 lineal feet, per ASTM E477

2.04 METAL JACKET

A. Smooth aluminum jacket 0.016 inch thick.
B. Integral polykraft or poly-surlyn moisture barrier.
C. Banded locking joints with field applied silicone weatherproof sealant.
D. Similar to Johns Manville Corp, or approved equal.

2.05 INSULATION ACCESSORIES

A. The following accessories shall be used in the application of the thermal insulations specified under this Section:
1. PVC Fittings Covers: similar to Johns Manville Corp "Zeston", or approved equal.
2. Pressure Sensitive polyester film tape to secure pipe insulation up to 12" outside diameter: Similar to 3M 30-80, or approved equal.
3. Vapor Seal Mastic: Similar to Childers CP-35, or approved equal.
4. Lagging Adhesive: Similar to Childers CP-52, or approved equal.
5. Wire: 16 gauge soft stainless steel.
6. Insulation Bonding Adhesive (To Metal): Similar to Childers CP-82, or approved equal.
7. Insulating and Finishing Cement: Similar to Insulco Smooth Kote, or approved equal.
8. Mechanical Fasteners - Welded or adhered pins with speed clip washers: Similar to Gemco Midwest Fasteners, or approved equal.
9. Bands for Equipment:
   a. Outside diameter of insulation is less than 24 inch: 1/2 inch x 0.020-inch (25 ga.) stainless steel.
   b. Where diameter is 36 inches or larger: 3/4 inch x 0.020 inch.
10. Bands for Piping: 1/2 inch x 0.020-inch stainless steel.

PART 3 - EXECUTION

3.01 INSULATION APPLICABILITY
A. Low Pressure Supply and Outside Air Ducts – Type F insulation required

<table>
<thead>
<tr>
<th>Insulation Thickness (in)</th>
<th>Duct Sizes (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>all</td>
</tr>
</tbody>
</table>

B. Domestic Water Heaters shall be factory insulated.

**Notes:**

a. Exhaust ductwork and stairwell pressurization ductwork is not insulated, unless otherwise noted.
b. Exposed supply and return ductwork will be double wall, internally lined.
c. All duct connected to equipment without compressors must be internally lined with Type G duct liner for a distance not less than 5 feet from the equipment connection.
d. All duct connected to equipment that contains compressors must be internally lined with Type G duct liner for a distance not less than 10 feet from the equipment connection.
e. The above thicknesses are the minimum required. All local codes and local energy codes shall be complied with.
f. All piping exposed to outdoors shall be insulated. All piping subject to freezing shall be provided with heat tracing. Coordinate insulation with heat trace cable and controls.
g. Insulation types and thickness are a minimum standard. Each application shall be carefully considered and insulation product type and thickness shall be appropriate for each specific application. Submit all insulation products with verification of their service intent.

3.02 PIPING INSULATION GENERAL REQUIREMENTS

A. Preparation

1. Do not apply insulation until piping has been leak tested.
2. All surfaces to be insulated shall be dry and free of loose scale, rust, dirt, oil or water.

B. Application:

1. Insulation shall be installed in a smooth, clean workmanlike manner. Joints shall be tight and finished smooth without fish-mouths.
2. Insulation shall fit tightly against the surface to which it is applied to prevent air circulation between the insulation and the pipe or equipment to which it is applied.
3. Insulation applied to cold piping or equipment shall be completely vapor sealed, free of pinholes or other openings.
4. Do not use wet insulation materials.
5. All longitudinal joints on vertical pipe runs shall be staggered.
6. Apply insulation so as to permit expansion or contraction of pipelines without causing damage to insulation or surface finish.
7. Do not apply mastic or adhesive until all previous applications of mastic and adhesives have thoroughly dried.
8. No bands or staples shall be provided on covering.
9. The adhesive used in connection with all covering work shall contain an approved vermin and rodent proof ingredient.
10. Provide 24-gauge sheet-metal saddle between the pipe hanger/support and the exterior of the insulation. Saddle length shall be the same as insulation inserts.

C. Application at Fittings:

1. Insulation of flanges and flanged fittings shall overlap adjacent pipe covering at least 1 inch. Valves shall be insulated up to the gland only.
2. Pipeline strainers shall be insulated in such a manner as to permit removal of strainer basket without disturbing insulation of the strainer body.
3. Insulation adjacent to un-insulated flanges shall be tapered back and neatly finished so as to allow access to and removal of bolts without injury to covering.

3.03 TYPE F INSTALLATION

A. Ductwork Insulation Application:
   1. Apply insulation tightly and smoothly to duct.
   2. Secure insulation on the bottom of ducts and plenums and on the sides of plenums and other places where the insulation will sag and max 3” from any corner.
   3. Impale insulation over pins or anchors located not more than 18 inches apart and hold in place with washers and clips.

   4. Cut off protruding pin after clips are secured and seal with 2-mil. aluminum foil backed pressure sensitive tape.
   5. Apply insulation with joints tightly butted.
   6. Seal all ductwork joints, punctures and fittings with a mastic type sealant containing a vapor barrier.
   7. Cover all breaks, joints, punctures and voids with a vapor seal mastic and cover with a vapor barrier material identical to vapor barrier on the insulation, where gaps exceed 2”.
   8. Bevel insulation around nameplates, access plates and doors.
   9. Insulation shall be continuous through walls and floors except at fire dampers.

3.04 TYPE G INSTALLATION

A. Internal Lining Insulation Application:
   1. Apply where specified herein.
   2. Apply liner in accordance with SMACNA Duct Liner Application Standard, later edition.
   3. Provide metal liner for the sound lining. Metal liner to be 24 gauge galvanized sheet metal with perforation of 3/32” diameter holes on 3/16” center. Properly fasten liner to the duct so that liner does not sag or vibrate.

3.05 METAL JACKET INSTALLATION

A. Cover all piping insulation exposed to the exterior with metal jacket as specified herein.

3.06 HANGERS

A. Continue insulation through pipe hangers. Provide either rigid insulation inserts or sheet metal inserts at all outside pipe hangers. Provide rigid insulation inserts for piping operating below 60 °F. and sheet metal inserts for piping above 60 °F.

B. Provide rigid insulation (on non-insulated piping) or sheet metal inserts (on insulated piping) between the pipe and pipe hanger - shall be of a thickness equal to the adjoining insulation and shall be provided with vapor barrier where required. Insulation insert shall not be less than the following lengths:

   - 1/2” to 2 1/2" pipe size: 10 Inches Long
   - 3” to 6" pipe size: 12 Inches Long
   - 8” to 10” pipe size: 16 Inches Long
   - 12” and over: 22 Inches Long

C. Inserts for cold piping shall have a vapor barrier facing of the same material as the adjacent pipe insulation. Seal inserts into insulation with vapor seal mastic.
D. Sheet metal inserts shall be of steel sheet. Gauge shall conform to manufacturer's recommendation for pipe size. Sheet metal inserts shall have insulation filler of the same material as the adjacent pipe insulation.

3.07 PIPE SLEEVES

A. Pipe insulation and vapor barrier shall be continuous through sleeves in walls and floors.

B. Provide 26 gauge galvanized steel or 0.020 inch aluminum jacket over insulation on pipe passing through sleeves where sealant is required.

C. Where penetrating interior walls, extend the metal jacket 2 inches out either side of the wall and secure each end with a metal band compressing the insulation slightly.

D. Where penetrating floors, extend the metal jacket 2 inches below the floor and 5 inches above the floor. Secure with metal bands.

END OF SECTION 23 07 00
SECTION 23 21 14

VALVES

PART 1 - GENERAL

1.01 SUMMARY

A. The General Provisions, Supplemental General Provisions, section 23 01 00, Division 1 Specifications and Special Provisions apply to all Work specified in this Section.

B. This section describes the basic materials and installation methods for the valves associated with the piping systems. Comply with other Division 23 sections and drawings as applicable. Refer to other divisions for coordination of work.

C. Furnish and install all components of the valves specified herein, as indicated on the drawings, and as required to provide complete and operating systems.

1.02 DESCRIPTION OF WORK

A. Work Included: Provide valves as specified and indicated.

1.03 QUALITY ASSURANCE

A. Acceptable Manufacturers: The model numbers listed in the Specifications establish a level of quality and material. The following manufacturers are acceptable, subject to compliance with the requirements of these Specifications.

1. General Valves: Jenkins Bros. Valves, Crane Company, Stockham Valves and Fittings, Walworth Company, Kennedy Valve, Kitz, Nibco, or approved equal

2. Ball Valves: Jenkins Bros. Valves, Jamesbury Corporation, Nibco, Stockham Valves and Fittings, Apollo, Kitz, approved equal.


5. Check Valves: Jenkins Bros. Valves, Crane Company, Muesco, Inc., APCO/Valve & Primer Corporation, Williams-Hager, Clow Pipeline Products, Valve Division, Nibco, Crane, Stockham, Milwaukee, Kitz, or approved equal.


PART 2 - PRODUCTS

2.01 MATERIALS

A. General: All valves shall be similar to numbers listed. All similar type and size valves shall be products of one manufacturer.

B. Refrigerant Valves: Valves manufactured specifically for use in refrigerant systems shall be used in such systems.

C. Butterfly Valves: All butterfly valves shall be full tapped and threaded lug type, manufacturer certified for bubble-tight, dead end shut off from either direction at design working pressure and temperature. Valves 2 1/2 through 5" in size shall have lever type operators. Valves 6" and larger shall have enclosed, self-locking worm gear type
operators, waterproof, and factory-lubricated. Gear segment shall be manganese bronze or ductile iron with a steel or ductile iron worm and oil impregnated bronze bushings or worm shaft. Operator shall have built in adjustable mechanical stops and position indicators. Valves used for balancing shall be certified suitable for continuous throttling service.

D. Ball Valves: Valves shall be furnished with blowout-proof stems. Valves used for chilled water service shall be insulated as specified for the pipe in which the valve is installed. All ball valves shall be full-line size to prevent flow restriction through the ball.

E. Gate Valves: All bronze gate valves shall have packing boxes with adequate depth to allow space for sufficient amounts of stem packing. Malleable iron handwheels and gland followers shall be furnished on all bronze gate valves. All gate valves shall have non-asbestos stem packing suitable for pressure and service. OS&Y and IBBM gate valves shall be furnished with a stem lubrication fitting on all sizes. All gate valves shall be designed to permit repacking while the valve is in line.

2.02 VALVES

A. Valves for service at or less than 150 PSIG:
   1. Block (Stop) Valves: Ball valves 2” and smaller shall be red brass, cast bronze, or yellow forged bronze with brass, stainless steel, or bronze ball and stem, 150 psig nonshock WOG at 200°F, Jenkins Fig. No. 900T. Valves 2 1/2” and larger shall be butterfly type, 200 psig nonshock WOG at 200°F, ANSI Class 150 with ductile iron lug body. The replaceable resilient elastomer seat shall be Buna N or EPDM. The disc shall be silicon or aluminum bronze and shaft shall be No. 316 or No. 416 stainless steel. Secondary O ring seals shall be provided at the top and bottom of the upper and lower shafts to guarantee zero leakage to the shaft, Jenkins Fig. No. 232EL/EG or No. 632E.
   2. Balancing Valves: Valves shall comply with the general requirements specified for block valves. Valves used for balancing shall have adjustable memory stops or position indicators. Valves 2” and smaller shall be Jenkins Fig. No. 900TE. Valves 2 1/2” and larger shall be Jenkins Fig. No. 232EL.
   3. Gate Valves: As a general rule, gate valves shall not be used for sizes 2 1/2” and smaller. If necessary, with prior approval from the Construction Manager, valves 2-1/2” and smaller shall be Jenkins Fig. No. 47-U, 200 psig WOG bronze body with screwed bonnet and ends. Valves 3” and larger shall be Jenkins Fig. No. 651-A, 200 psig WOG.
   4. Globe Valves: Valves 2” and smaller shall be Jenkins Fig. No. 546-P, bronze body, bronze rising stem, screw in bonnet, renewable seat, and screwed or solder ends. Valves 2 1/2” and larger shall be Jenkins Fig. No. 613, 200 psig WOG, outside screw and yoke (OS&Y), iron body, bronze-trimmed, renewable seat, Pressure Class 125, with ANSI B16.1 flanged ends.

B. Valves for Service Over 150 PSIG:
   1. Block Stop Valves: Ball valves 2” and smaller shall be red brass cast bronze or yellow forged bronze with brass, stainless steel, or bronze ball and stem, 300 psig nonshock WOG at 200°F with Teflon packing and gaskets, Jenkins Fig. No. 900T. Valves 2 1/2” and larger shall be 300 psig nonshock WOG, with Class 300 ANSI B16.5 flanges, full tapped and threaded cast steel lug body. Valves shall have 300 pounds body drilling and shall be suitable for service indicated on the Plans. Disc shall be cast steel and the shaft shall be No. 416 stainless steel. Secondary O ring or gland seals at the top and bottom of the upper and lower shafts shall guarantee zero leakage to the shaft. Seals and backing rings shall be TFE or Viton. Seal retainer rings shall be No. 316 stainless steel, Dezurik No. 645.
2. Balancing Valves: Valves shall comply with the general requirements specified for block valves. Valves used for balancing shall have adjustable memory stops or position indicators.

3. Gate Valves: As a general rule, gate valves shall not be used for sizes 2 1/2" and smaller. If necessary, with prior approval from the Construction Manager, valves 2-1/2" and smaller shall be Jenkins Fig. No. 270-U, 300 pounds WOG, bronze body, rising stem, with screwed bonnet and screwed ends. Valves 3" through 12" shall be Jenkins Fig. No. 204, 500 pounds WOG, OS&Y valves with Class 250 ANSI B16.1 flanged ends, cast iron body and bronze trim.

4. Globe Valves: Valves 2" and smaller shall be Jenkins Fig. No. 556-P, 400 pounds WOG, bronze body and trim, rising stem, union bonnet, renewable seat, and screwed ends. Valves 2 1/2" through 8" shall be Jenkins Fig. No. 923, 500 pounds WOG, iron body, bronze trim rising stem, OS&Y Class 250 ANSI B16.1 flanged ends.

C. Check Valves: Chilled, hot, condenser, and domestic water pipes 2 1/2" and larger shall be Williams-Hager Fig. No. 375, spring-loaded, quiet type. Valve nonshock pressure temperature rating shall be as specified for piping in which it is installed. Valve shall be full-threaded, lug body, or flanged body. Valves 2" and smaller shall be Jenkins Fig. No. 92A. Threaded valves installed at pump discharge shall have its shaft perpendicular to the pump shaft. Valves located in pumped sewage pipes and in storm pipes shall be Crane No. 383 outside weight, 200 pounds WOG, iron body, bronze trimmed, with swing check design.

D. Relief Valve: Temperature and pressure, self-closing, lever operated with thermo-bulb extension, 3/4", ANSI B2.1 taper thread male inlet connection, 210°F (98.8°C) and 125 psig setting, ANSI Z1.22, Type No. 40XL Watts Regulator Company.

E. Combination Pressure Reducing and Relief Valve for Make up Water: Bell and Gossett Model Number 3, dual unit.

F. Reduced Pressure Backflow Preventer: Backflow preventer shall be Watts Regulator No. 909 Series, 2 1/2" and larger shall be provided with dual "Y" pattern spring-loaded check valves and independent relief valve located between checks. Backflow preventers shall be rated for pressure up to 150 psig working pressure at 140°F (60°C) and sized according to the maximum design flow.

G. Domestic Water Pressure Reducing Valves: Watts 223S or Clayton 90G 01. Pressure and flow schedule as indicated on the Drawings.

H. Valves for Gas Connections: Valves 2" and smaller shall be Crane Fig. 254; valves 2 1/2 to 5" shall be Walworth Fig. 1797 F; and valves 6 to 12" shall be Walworth Fig. 1718 F.

2.03 FIRE PROTECTION VALVES

A. Check Valves: Valves 2" and smaller shall be threaded end Jenkins Fig. No. 92A. Valves 2 1/2" and larger shall be Jenkins Fig. No. 729 flanged, iron body, bronze mounted (IBBM) swing check, 175 psig WOG, with renewable composition disc and bronze seat ring, Underwriters' Laboratories, Inc. (UL) and/or Factory Mutual (FM) approved as required. Where ball drip is required, provide Jenkins Fig. No. 624 with Grinnell Fig. 1686 plain discharge.

B. OS&Y Valves: Valves 2" and smaller shall be Jenkins Fig. No. 275U, 175 psig WOG, threaded, all bronze, gate valve, UL approved. Valves 2 1/2" and larger shall be Jenkins Fig. No. 825A, 175 psig WOG, flanged, gate valve, IBBM, solid wedge, UL and FM approved. Provide OS&Y valves with tamper switches installed where indicated.
PART 3 - EXECUTION

3.01 INSTALLATION

A. General: Except as otherwise indicated, comply with the following requirements.

B. Ball Valves: Provide ball valves on chilled water pipes at each runout to a piece of equipment, at each coil, and elsewhere as shown on the Drawings.

C. Valve Stems: Install valves with stems pointed up, in the vertical position where possible, but in no case with stems pointed downward from a horizontal plane.

D. Chain Operators: In central plant and in fan or mechanical rooms where chilled water and condenser water valves are installed over 8’ above floor, provide chain operators.

E. Swing Check Valves: Swing check valves shall be installed in horizontal piping only.

F. Unions and Companion Flanges: Provide unions or companion flanges where required to facilitate dismantling of valves and equipment.

G. Access Doors and Panels: Verify the location and quantity of access doors or panels required to provide full valve access.

END OF SECTION 23 21 14
SECTION 23 23 00
REFRIGERANT PIPING

PART 1 – GENERAL

1.01 RELATED DOCUMENTS
A. The conditions of the contract and applicable requirements of Division 1, “General Requirements”, and Section 23 01 00, “Basic Mechanical Requirements”, govern this Section.

1.02 DESCRIPTION OF WORK
A. Work Included: Refrigerant piping including suction, liquid, discharge and condenser drain piping between compressors, evaporators, condensers and receivers for direct expansion air conditioning and refrigeration systems.
B. Work of Other Sections: Section 15140, “Pipe Hangers, Supports, and Anchors”, Section 15250, “System Insulation”

1.03 QUALITY ASSURANCE
A. Provide piping as described by ANSI B31.5, Refrigeration Piping and ASTM B75, Seamless Copper Tube.
B. Provide fittings as described by ANSI B17.22, Wrought Copper and Bronze Solder-Joint Pressure Fittings and SAE J513F, Refrigeration Tube Fittings.
C. Comply with material and installation requirements of ASHRAE 15, Safety Code for Mechanical Refrigeration.
D. Comply with material and installation requirements of:
   1. ARI 710, Liquid-Line Dryers
   2. ARI 750, Thermostatic Refrigerant Expansion Valves
   3. ARI 730, Flow-Capacity Rating and Application of Suction-Line Filters and Filter Dryers
   4. ARI 495, Refrigerant Liquid Receivers
   5. ARI 770, Refrigerant Pressure Regulating Valves
   6. UL 207, Refrigerant Containing Components and Accessories, Non-electrical

PART 2 – PRODUCTS

2.01 MATERIAL
A. Pipe
   1. Seamless Copper Tube, Hard Drawn
      a. All sizes are to be type ACR ASTM B75 or Type K or L ASTM B88
B. Fittings
   1. Ells, Tees, Couplings, Caps, Reducers –
      a. Wrought copper or wrought bronze with silver solder, ASTM B16.22
2.02 EQUIPMENT

A. Provide refrigerant specialties of sizes, types, ratings and capacities required to comply with installation requirements.

B. Refrigerant Valves:
   1. Globe Shutoff Valves:
      a. Cast iron, packed, back seating type with winged seal cap.
      b. 300°F temperature rating, 300 psi working pressure.
   2. Check Valves:
      a. Cast iron, accessible internal parts.
      b. 300°F temperature rating, 300 psi working pressure.
   3. 2-Way Solenoid Valve:
      a. Forged brass or steel, normally closed, Teflon valve seat.
      b. NEMA 1 solenoid enclosure, 24 volt, 60 Hz., UL-listed, ½” conduit adapter.
      c. 300°F temperature rating, 500 psi working pressure.
      d. Provide manual operator to open valve.

C. Refrigerant Strainers
   1. Straight line or angle line type.
   2. Brass shell and end connections.
   3. 100 mesh, stainless steel screen.
   4. UL-listed.
   5. 430 psi working pressure.

D. Moisture – Liquid Indicator:
   1. Copper plated steel with solder connections.
   2. Paper indicator element held under sight glass.
   3. UL-listed.
   4. Rated working pressure 430 psi.

E. Filter – Dryers (Sealed Core):
   1. Steel shell.
   2. Molded desiccant core.
   3. Solder or flare connections.
   4. UL-listed.
   5. 500 psi working pressure.

F. Filter – Dryers (Replaceable Core):
   1. Steel Shell with bolted end plate.
   2. Replaceable molded desiccant core.
   3. Solder or pipe connections.
   4. UL-listed.
   5. 500 psi working pressure.

G. Evaporator Pressure Regulator:
   1. Steel body.
   2. Pressure operated, adjustable pressure regulator.
   3. Solder connections.

H. Thermostatic Expansion Valve:
   1. Brass body and stainless steel diaphragm.
   2. Externally adjustable.
   3. External pressure equalizer.
   4. Removable inlet strainer.
5. Flare connections.
6. Strap-on bulb with 5’ of tubing.

I. Receiver:
   1. Copper shell with brazed points and fusible relief plug.
   2. 450 psi working pressure
   3. Flare connections.

PART 3 – EXECUTION

3.01 EXAMINATION

   A. Examine areas and conditions under which refrigerant piping is to be installed.
   B. Do not proceed with work until satisfactory conditions are present.

3.02 INSTALLATION OF REFRIGERANT PIPING AND SPECIALTIES

   A. Install refrigerant piping in accordance with piping and equipment manufacturer’s recommendations.

   B. Install refrigerant piping with 1/8” per foot (1%) downward slope in direction of oil return to compressor.

   C. Provide oil traps and double risers where required to provide oil return.

   D. Clean refrigerant piping by swabbing with dry lint-free cloth, followed by refrigerant oil soaked swab.

   E. Remove excess oil by swabbing with cloth soaked in high flash point petroleum solvent, squeezed dry.

   F. Bleed dry nitrogen through refrigerant piping during brazing operations.

   G. Install refrigerant valves in accordance with manufacturer’s instructions.

   H. Remove accessible internal parts before soldering or brazing, replace after joints are completed.

   I. Install solenoid valves with stem pointing upwards.

   J. Install accessories in locations accessible for service.

   K. Adjust evaporator pressure regulators, if required, for proper evaporator pressure.

   L. Install filter drier cores after leak test but before evacuation.

3.03 EQUIPMENT CONNECTIONS

   A. Connect refrigerant piping to mechanical equipment according to equipment manufacturer’s instructions.

3.04 DEHYDRATION AND CHARGING SYSTEM
A. After testing and acceptance of installation, evacuate refrigerant system with vacuum pump until 35°F temperature is reached on vacuum dehydration indicator.

B. During evacuation, apply heat to pockets, elbows, and low spots in piping.

C. Maintain vacuum on system for minimum of 5 hours after closing valve between vacuum pump and system.

D. Break vacuum with refrigerant gas, allow pressure to build up to 2 psi.

E. Complete charging system using new filter dryer core in charging line.

F. Provide full operating charge.

END OF SECTION 23 23 00
SECTION 23 30 00

DUCTWORK

PART 1 - GENERAL

1.01 SUMMARY

A. The General Provisions, Supplemental General Provisions, section 23 01 00, Division 1 Specifications and Special Provisions apply to all Work specified in this Section.

B. This section describes the basic materials and installation methods for the duct systems. Comply with other Division 23 sections and drawings as applicable. Refer to other divisions for coordination of work.

C. Furnish and install all components of the duct systems specified herein, as indicated on the drawings, and as required to provide complete and operating systems.

D. All adhesives, mastics, glues, sealants, etc… shall meet the LEED requirements.

1.02 DESCRIPTION OF WORK

A. Work Included:
   1. Provide sheet metal ductwork as specified herein.

B. Types: The types of ductwork specified in this Section include, but are not necessarily limited to the following:
   1. Air conditioning cooling and/or heating supply and return air systems
   2. Outdoor air supply systems
   3. Mechanical exhaust systems
   4. Air relief systems
   5. Kitchen exhaust systems
   6. Boiler breeching and boiler flue

C. Supply Air Ductwork Downstream of Fan Coil Units: Ductwork shall be sheet metal designed for velocities up to 1,500 fpm or a friction rate of 0.08 inches water column per 100 feet of duct, whichever is most stringent. The ductwork shall meet the latest SMACNA Standards for construction and stiffening based on the maximum pressure in the ductwork. Ductwork shall be 1” W.C. pressure class.

D. Outside Air Ductwork (fan forced): Ductwork shall be sheet metal ductwork designed for velocities up to 2,500 fpm. The ductwork shall meet the latest SMACNA Standards for construction and stiffening based on the maximum pressure in the ductwork. Ductwork shall be 1” W.C. pressure class.

I. Restroom and General Exhaust Ductwork: Ductwork shall be sheet metal ductwork designed for velocities up to 1,500 fpm. The ductwork shall meet the latest SMACNA Standards for construction and stiffening based on the maximum pressure in the ductwork. Ductwork shall be 1” W.C. pressure class.

J. Grease exhaust ductwork shall be designed for velocities up to 2,500 FPM. The ductwork shall meet the latest SMACNA standards for construction and stiffening based on the maximum pressure in the ductwork. Grease exhaust duct material and installation shall meet the requirements of NFPA 96 and shall be either 16 GA black carbon steel or 18 GA stainless steel, sloping at a minimum of ¼” / foot back toward the hood. All grease exhaust duct shall be welded and leak-tested. Cleanouts should be provided at least every 12 feet and at each change in direction.
K. Flexible Ductwork: Ductwork connections to HVAC terminal units and air devices shall be made with flexible ductwork connection where shown on the Drawings. Additional connections may be made using flexible ductwork at the Contractors opinion, where approved in writing, in advance, by the Engineer.

L. Ductwork Insulation: Refer to section 23 07 00, “HVAC Insulation”, for duct insulation.

M. Ductwork Accessories: Refer to Section 23 33 00, “Ductwork Accessories”, for accessories and specialties related to ductwork systems and installation.

1.03 QUALITY ASSURANCE

A. Design and Installation Standards:
   2. ASHRAE Standards: Comply with American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE 70-72), Method of Testing for Rating the air flow performance of outlets and inlets.

B. Fire and Smoke Rating Test Standards: ASTM E84, NFPA 255 and UL 723.

1.04 SUBMITTALS

A. Shop Drawings: Submit dimensioned layouts of ductwork showing both the accurately scaled ductwork and its relation to space enclosure. Show modifications of indicated requirements, made to conform to local shop practice and how those modifications ensure that the free area, materials, and weights are not reduced. The shop drawings must be submitted at ¼” = 1'-0” or larger scale and shall include all equipment connected to the duct systems, drawn to scale, based on the equipment submittals. All ductwork and equipment must indicate bottom elevations, referenced to finished floor below (bottom of duct = X'-Y” AFF, e.g.)

PART 2 - PRODUCTS

2.01 DUCTWORK MATERIALS

A. Exposed Ductwork Materials: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, oil canning, stains, discolorations, and other imperfections, including those which would impair painting.

B. Gauges, Rectangular Ductwork: Fabricate galvanized steel ductwork from the minimum gauges for sizes up to the corresponding maximum long-side dimensions as indicated in SMACNA Duct Construction Standards.

C. Gauges, Round Ductwork: Fabricate lock-form quality galvanized steel ductwork from the minimum gauges for diameters up to the corresponding maximum dimensions as indicated in SMACNA Duct Construction Standards.

D. Fiberglass Duct board: Fiberglass duct board is NOT an acceptable means of air transport.
2.02 MISCELLANEOUS DUCT MATERIALS

A. General: Provide miscellaneous materials and products of the types and sizes indicated and where not otherwise indicated, provide type and size required to comply with ductwork system requirements including proper connection of ductwork and equipment.

B. Duct Sealant: Provide non-hardening, non-migrating mastic or liquid elastic sealant (type applicable for the fabrication/installation detail) as compounded and recommended by the manufacturer specifically for sealing joints and seams in ductwork.

C. Ductwork Support Materials: Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, rods, straps, trim, and angles for support of ductwork.


E. Duct Liner Fasteners: Comply with SMACNA.

F. Flexible Ductwork: Insulated flexible ductwork shall be Wiremold Type VTCK. Approved equal flexible ductwork by Certainteed Corporation, Flexaust Company, Genflex or Owens-Corning Fiberglass will be acceptable. Provide either 45 degree angle taps with manual volume dampers or "spin-in" taps with manual volume dampers at main duct tap as shown on Drawings.

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS


B. All ductwork required for the heating, ventilating and air conditioning systems shall be constructed and erected in a first class workmanlike manner. This work shall be guaranteed for a period of one year from and after the date of acceptance of the job against noise, chatter, whistling, vibration, and free from pulsation under all conditions of operation.

C. The interior surface of all ductwork shall be smooth with no parts projecting into the air stream unless specified to do so. All seams and joints shall be external. The inside of all ductwork shall be thoroughly cleaned and all fans operated to remove any debris prior to connection of air devices.

D. All holes in ducts for damper rods and other necessary devices shall be either drilled or machine punched (not pin punched), and shall not be any larger than necessary. All duct openings shall be provided with sheet metal caps if the openings are to be left unconnected for any length of time.

E. Where ducts, exposed to view (including equipment rooms), pass through walls, floors or ceilings, furnish and install sheet metal collars around the duct.

F. Sheet metal plenums shall be constructed and reinforced in accordance with SMACNA standards. Where plenums are connected to louvers, the plenum bottom shall be sloped to drain to the louver.

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G. Ductwork which is exposed to weather shall have soldered joints and seams and shall be painted with a suitable epoxy coating. In lieu of solder joints, the use of duct-mate or TDC manufactured flanges are acceptable.

3.02 COORDINATION

A. Prior to submitting ductwork shop drawings, the Division 23 Contractor shall fully coordinate the routing and height of all ductwork with all other trades and with ceiling heights, lighting fixtures and building construction.

3.03 GENERAL DUCTWORK FABRICATION

A. Duct Gauge and Reinforcing:
   1. Rectangular Ductwork: Minimum metal gauges and reinforcement shall be in accordance with SMACNA HVAC Duct Construction Standards (SDCS) Tables 1-3 through 1-13. Minimum aluminum gauges and reinforcement shall be in accordance with SDCS Tables 1-14 through 1-16. Reinforcing shall be installed per SDCS Fig. 1-9 through 1-12.
   2. Round Ductwork: Minimum metal gauges for longitudinal and spiral seam round ductwork shall be in accordance with SDCS Table 3-2. Minimum aluminum gauges for longitudinal and spiral seam round ductwork shall be in accordance with SDCS Table 3-3. Longitudinal seam ductwork larger than 12” diameter shall not be permitted unless welded seams are used.
   3. Cross-breaking: Cross-break or transverse bead all flat surfaces which are more than 12” wide. Transverse beading shall be on 12” centers and shall be a minimum of 1/8” deep at the center of the bead and 3/8” wide at the base of the bead.
   4. Minimum Gauges: The metal gauges listed in the SDCS for round and rectangular ductwork are the minimum recommended. It shall be the Contractor’s responsibility to select a metal gauge heavy enough to withstand the physical abuse of installation.

B. Duct Joints And Seams:
   1. General: Make all joints airtight. The distance between transverse joints on any size duct shall not exceed 5’.
   2. Rectangular Ductwork: Transverse joints and longitudinal seams in ductwork shall be constructed in accordance with SDCS Fig. 1-4 and 1-5. Drive slips may be used on rectangular ductwork on short sides only, up to 18” maximum. Gauge of drive slips shall be at least as heavy as ductwork on which they are installed. Bend drive slips over at least 3/4” at corners. Corner closures shall be in accordance with SDCS Fig. 1-13 through 1-18. All longitudinal seams shall be "Pittsburgh Lock" or button punch snap lock at corner seams and grooved seam or seam welded in sides between corners, in accordance with SDCS Fig. 1-5. At the Contractor’s option, transverse joints may be transverse duct flange joints or Ductmate EP12/11prefabricated galvanized “Ductmate” sections. The proposed gasket material, flange, corner piece and Ductmate details shall be submitted for approval.
   3. Round Ductwork: Transverse joints for round ductwork shall be beaded sleeve type constructed in accordance with SDCS Fig. 3-2, properly secured and sealed. Draw bands shall not be used on round ductwork. Longitudinal and spiral seams shall be constructed in accordance with SDCS Fig. 3-1.
   4. Ductwork Sealing: Seal all longitudinal and transverse ductwork joints and seams using SMACNA ductwork sealant and 3" wide open weave tape to provide positive seal. Sufficient sealant shall be used to completely imbed the cloth.

C. Connections and Take-offs:
   1. Rectangular Ductwork: Parallel flow branches shall be constructed using radius elbow take-offs in accordance with SDCS Fig. 2-7. Branch duct connections shall be
45 degree entry expanded taps constructed in accordance with SDCS Fig. 2-8. Duct-mounted coil connections shall be constructed in accordance with SDCS Fig. 2-11.

2. Round Ductwork: Connections and takeoffs shall be made using 90 degree conical taps, 45 degree lateral taps or wye fittings constructed in accordance with SDCS Fig. 3-4 and 3-5. Use of 90 degree tees shall not be allowed.

3. Spin-in Fittings: Spin-in fittings may be used for duct taps to air supply and exhaust devices and shall include quadrant dampers even though a volume damper may be specified for the air device. Spin-in fittings shall be sealed at the duct tap with a gasket and compression fit or sealed with duct sealant. The location of spin-in fittings in the ducts shall be determined after terminal units are hung and the location of the light fixtures is known so as to minimize flexible duct lengths and sharp bends. Spin-ins shall be installed with their damper axis parallel to airflow. A minimum of 18” must be provided between fittings.

4. Flexible Joints In Ductwork: Provide flexible connections where ductwork connects to air-handling units, fans, and similar powered equipment items and where required for expansion and contraction of the ductwork or the building structure. A minimum of one inch (1”) slack shall be provided in all flexible connection to insure vibration isolation. Flexible joints are not required where equipment is connected with flexible duct. Flexible connections shall be rigidly connected to metal work on each side and shall be airtight. Bond flanges of flexible duct connectors to ducts and housings to provide airtight connections. Seal seams and penetrations to prevent air leakage.

D. Elbows and Tees:
1. Rectangular Ductwork: Provide radius or square elbows in ductwork, where shown on the Drawings. Where radius elbows are shown, radius elbows must be provided. Where square elbows are shown, square or radius elbows may be provided, at the Contractor’s option. Elbows shall be constructed in accordance with SDCS Fig. 2-2. Turning vanes are required in all square elbows of 46 degrees or greater angle. Turning vanes are not required in radius elbows. Turning vanes shall be single vane type without a trailing edge and shall be constructed and installed in accordance with SDCS Fig. 2-3 and 2-4.
2. Round Ductwork: Provide radius elbows of the stamped or segmented type constructed in accordance with SDCS Fig. 3-3. Segmented elbows shall have a minimum of three segments for 45 degree elbows and five segments for 90 degree elbows.

E. Offsets and Transitions: Where duct width increases, maximum angle of slope shall be 20 degrees (one inch (1”) in 2.7”). Where duct width decreases, maximum angle of slope shall be 30 degrees (one inch (1”) in 1.7”). Offsets and transitions shall be constructed in accordance with SDCS Fig. 2-9 and 2-10.

F. Air Device Connections: Make connections to air devices and fabricate air device plenums as detailed on the Drawings and in accordance with SDCS Fig. 2-16 through 2-18.

3.04. DUCTLINER

A. General: The liner shall be applied to the inside of the duct with heavy density side to the air stream and shall be secured in the duct with adhesive, completely coating the clean sheet metal. All joints in the insulation shall be "buttered" and firmly butted tightly to the adjoining liner using fireproof adhesive. Where a cut is made for duct taps, etc., the raw edge shall be accurately and evenly cut and shall be thoroughly coated with fireproof adhesive. On ducts over 24’’ in width or depth, the liner shall be further secured with mechanical fasteners. The fasteners shall be A.J. Gerrard Company pronged straps, or approved equal, secured to the ducts by fireproof adhesive. The clips shall be 18” maximum spacing and shall be pointed up with fireproof adhesive. Liner shall be accurately cut and ends thoroughly coated with fireproof adhesive so that when the duct
section is installed, the liner shall make a firmly butted and tightly sealed joint. Where ducts are lined exterior insulation will not be needed unless otherwise noted, except that the two insulations shall lap not less than 24". Ductliner for velocities over 2,000 fpm shall be as specified except a perforated metal liner shall be used over ductliner for securement, in lieu of fasteners. Ductliner installation and fasteners shall comply with SDCS Fig. 2-22 through 2-25.

3.05 DUCTWORK INSTALLATION

A. General: Assemble and install ductwork in accordance with recognized industry practices which will achieve airtight and noiseless systems, capable of performing each indicated service. Install each run with a minimum of joints. Align ductwork accurately at connections, within 1/8" misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers, and anchors of the type which will hold ducts true-to-shape and prevent buckling.

B. Inserts: Install concrete inserts for support of ductwork in coordination with formwork, as required to avoid delays in the work.

C. Completion: Complete fabrication of work at the project as necessary to match shop-fabricated work and accommodate installation requirements.

D. Run Location: Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, grams, details, and notations or, if not otherwise indicated, run ductwork in the shortest route which does not obstruct usable space or block access for servicing the building and its equipment.

Hold ducts close to walls, overhead construction, columns, and other structural and permanent-enclosure elements of the building. Limit clearance to 0.5" where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork to assure 1.0" clearance of insulation. Wherever possible in finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown. Coordinate the layout with suspended ceiling and lighting layouts and similar finished work.

E. Coordination: Coordinate duct installation with installation of accessories, dampers, coil frames, equipment, controls, and other associated work of the ductwork system.

F. Hangers and Supports:
   1. General: All ductwork supports shall be per Section IV of the SMACNA "HVAC Duct Construction Standards - First Edition" with all supports directly anchored to the building structure. Supports shall be on maximum 8'-0" centers with additional supports as required to prevent sagging.
   2. Attachment to Structure: Provide hanger attachment to the building structure as specified in Section 15100, "Basic Materials and Methods", and in accordance with SDCS Fig. 4-1 through 4-3.
   3. Hangers: Hangers shall be strap or rod sized in accordance with SDCS Table 4-1 and 4-2. Strap hanger attachment to rectangular duct shall consist of a turning strap under the duct a minimum of one inch (1") and securing the strap with one screw into the bottom of the duct and one screw to the side of the duct. Rectangular duct supported on trapeze hangers shall be attached to the trapeze. Round duct attachments shall be constructed in accordance with SDCS Fig. 4-4.
   4. Horizontal Ducts: Ducts larger than 50" in their greatest dimension shall be supported by means of hanger rods bolted to angle iron or half round trapeze
hangers. Duct shall have at least one pair of supports 8'-0" on centers according to the following:

<table>
<thead>
<tr>
<th>Angle</th>
<th>Angle</th>
<th>Rod Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>4'-0&quot;</td>
<td>1-1/2&quot; x 1-1/2&quot; x 1/8&quot;</td>
<td>1/4&quot;</td>
</tr>
<tr>
<td>6'-0&quot;</td>
<td>1-1/2&quot; x 1-1/2&quot; x 1/8&quot;</td>
<td>1/4&quot;</td>
</tr>
<tr>
<td>8'-0&quot;</td>
<td>2&quot; x 2&quot; x 1/8&quot;</td>
<td>5/16&quot;</td>
</tr>
<tr>
<td>10'-0&quot;</td>
<td>3&quot; x 3&quot; x 1/8&quot;</td>
<td>3/8&quot;</td>
</tr>
</tbody>
</table>

5. Vertical Ducts: Ducts shall be supported where they pass through the floor lines with 1-1/2" x 1-1/2" x 1/4" angles for ducts up to 60". Above 60", the angles must be increased in strength and sized on an individual basis considering space requirements.

G. Flexible Ductwork:
1. General: Flexible ductwork shall be provided as shown on Drawings. Flexible ducts shall be installed in a fully extended condition free of sags and kinks, using only the minimum length required to make the connection, subject to the maximum lengths herein and below. Bends in any length of flexible duct shall not exceed 45 degrees for HVAC terminal unit connections or 135 degrees for air device connections and shall not exceed that recommended by the flexible ductwork manufacturer. Unless otherwise shown on the Drawings, the length of any one run of flexible ductwork shall not exceed 2 feet to terminal units or 6 feet to air devices.
2. Supports: Where flexible duct extension exceeds 48", horizontally, a support shall be provided. Duct shall be suspended on 48" centers with a minimum two inch (2") wide flat banding material. Refer to SDCS Fig. 3-9 and 3-10 and Page 3-17 for additional requirements.
3. Terminal Unit Flexible Duct Connections: The terminal ends of the duct core shall be secured by stainless steel worm gear type clamps. The fittings on terminal units and on sheet metal duct shall be coated with sealant, then the flexible duct core slipped over duct and the clamp tightened, and the connections shall be sealed with duct sealant. Insulation of flexible duct shall be slipped over connection to point where insulation abuts terminal unit or insulation on duct and attached with self-locking nylon straps. The insulation connections shall then be sealed using foil duct tape to provide vapor barrier. Refer to SDCS Page 3-13 and 3-15 for additional requirements.
4. Air Device Flexible Duct Connections: All joints and connections shall be made by turning back the insulation and securing the inner liner with self-locking nylon straps and sealing with two wraps of duct tape. The insulation shall then be placed over the joint, attached with a self-locking nylon strap and sealed on the exterior with an approved foil duct tape. Refer to SDCS Page 3-13 and 3-15 for additional requirements.

H. Duct Mounted Devices:
1. Install duct mounted sensors and control devices furnished under Section 23 09 00, "Building Controls". Provide access doors at each duct mounted control device. Coordinate location of devices and installation requirements with the Section 23 09 00Contractor.
2. Install duct type smoke detectors furnished under Division 26. Provide access doors at each sampling tube assembly. Coordinate location of detectors and installation requirements with Division 26.
3. Provide duct test ports in ductwork as required to properly balance all air systems. Test ports shall be located per ANSI/ASHRAE Standard III to allow accurate pitot-tube traverse measurements in ductwork.

3.06 CLEANING AND PROTECTION
A. General: Clean ductwork internally, section-by-section of dust and debris as it is installed. Clean external surfaces of foreign substances which might cause corrosive deterioration of the metal or, where ductwork is to be painted, might interfere with painting or cause paint damage.

B. Repairs: Strip protective paper from stainless ductwork surfaces and repair finish or replace ductwork portion wherever it has been damaged.

C. Temporary Closure: At ends of ducts which are not connected to equipment or air distribution devices at the time of ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent the entrance of dust and debris until such time that connections are to be completed.

END OF SECTION 23 30 00
SECTION 23 33 00

DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

A. The General Provisions, Supplemental General Provisions, section 23 01 00, Division 1 Specifications and Special Provisions apply to all Work specified in this Section.

B. This section describes the basic materials and installation methods for the ductwork accessories. Comply with other Division 23 sections and drawings as applicable. Refer to other divisions for coordination of work.

C. Furnish and install all components of the ductwork accessories specified herein, as indicated on the drawings, and as required to provide complete and operating systems.

1.02 DESCRIPTION OF WORK

A. Work Included: Provide ductwork accessories as required for the project including the following:
   1. Turning vanes,
   2. Monitors,
   3. Access doors,
   4. Fire dampers.

1.03 QUALITY ASSURANCE


B. ASHRAE Standards: Comply with American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc. (ASHRAE) recommendations pertaining to construction of ductwork accessories.

1.04 SUBMITTALS

A. Shop Drawings: Show modifications of indicated requirements, if applicable, made to conform to local shop practice and show how these modifications ensure that the materials and weights are not reduced and that the fabricated units are equivalent to the specified requirements in every significant way.

PART 2 - PRODUCTS

2.01 DUCTWORK ACCESSORIES, FABRICATION AND MATERIALS

A. General: Provide ductwork accessories that comply with the Section 15891, "Ductwork", and other applicable product requirements of ductwork materials noted in this Section.

2.02 FLEXIBLE CONNECTIONS

A. General: Flexible connections shall be UL-labeled, 30 ounces glass fabric-lined with insulation and coated on both sides with neoprene, complete with attachment accessories, "Vent-Glass" by Vent-Fabrics, Inc. or approved equal.
2.03 DUCTWORK HARDWARE

A. General: Damper operators for concealed inaccessible ductwork shall be Young Regulator Company, Catalog No. 700 or No. 315, as shown. Non-insulated accessible ductwork shall be Young Regulator Company, Catalog No. 433. Accessible insulated ductwork shall be Young Regulator Company, Catalog No. 443. Approved equal units by Duo-Dyne or Vent Fabrics, Inc. will be acceptable.

2.04 DIRECTIONAL, VOLUME CONTROL, AND FIRE DAMPERS

A. General: Provide all direction and volume control and fire dampers shown or noted on Drawings. All damper control devices shall be installed so as to be fully concealed in finished rooms and spaces.

B. Control Dampers:
   1. Pressure Taps: Where rectangular take-offs of branches from main ducts are used with 45 degree entry, provide manual volume regulators with lockable operators and nylon bushings on both sides of damper blade rod.
   2. Round Taps: Where taps to main ducts or their branches are made, provide 45 degree angle taps or 90 degree spin-in taps with manual volume dampers with nylon bushings on both sides of damper blade rod.
   3. Multi-leaf Dampers: Where multi-leaf dampers are required, provide opposed blade-type in accordance with Figure 2-12, SMACNA "Low Velocity Duct Construction Standards".

C. Fire Dampers: Provide fire dampers at duct penetrations of floors, smoke partitions, fire walls, and where required by the applicable building codes or authority having jurisdiction. Fire dampers shall comply with state and local codes, be inspected and approved by an approved inspection agency and be labeled at the factory in accordance with Uniform Building Code Standard 43, Section 43.714.
   1. Provide one-hour rated dampers where penetrations are in required one-hour fire rated assemblies.
   2. Provide 1-1/2 hour rated dampers where penetrations are in required 2-hour fire rated assemblies.
   3. Provide 3 hour rated dampers where penetrations are in required 4-hour fire rated assemblies; 4-hour occupancy separating walls are accepted.

2.05 FLASHING AND COUNTER-FLASHING

A. General: Flashing and counter-flashings shall be as specified in other Divisions of these Specifications.

2.06 DUCT ACCESS DOORS

A. General: Provide hinged duct access doors, gasketed and with insulation where ductwork is indicated to be insulated. Provide construction per SMACNA Standards. Access doors shall be at least 15" x 15".

B. Inspection Plates: Provide inspection plates as required. Provide a minimum opening of 4" x 4" with a 6" x 6" cover plate. The cover plate shall be one gauge heavier than the ductwork, gasketed and secured with a minimum of eight sheetmetal screws.

2.07 MISCELLANEOUS DUCTWORK MATERIALS
A. General: Provide miscellaneous materials for ductwork accessories, including hinges, refrigerator latches, sash locks, bolts and wing nuts, gaskets and pitot tubes as recommended by the ductwork accessories manufacturer for the application indicated.

2.08 TURNING VANES

A. Construct turning vanes in accordance with SMACNA Standards (current edition).

PART 3 - EXECUTION

3.01 INSTALLATION

A. Access Doors: Install access doors so that the doors open against the system air pressure wherever feasible and that their latches are operable from either side, except where the duct is too small to be entered. Provide access to each fire damper link to permit resetting. Comply with the applicable building codes or authority having jurisdiction and NFPA 96.

B. Inspection Plates: Install plates at each primary zone damper and where otherwise required for inspection of operable mechanisms within the duct systems.

C. Multileaf Dampers: Install multileaf volume dampers in each zone duct of multizone units and as otherwise required for balancing.

D. Turning Vanes:
   1. Install turning vanes for all rectangular mitered elbows. Install turning vanes in accordance with SMACNA Standards.
   2. Turning vanes for Ducts with air velocity less than 2500 FPM: Use single wall type vanes for ducts having width equal to or less than 12 inches.
   3. Use double wall type vanes for (2” radius, 2–1/8” spacing) for ducts having widths greater than 12 inches.
   4. If duct sizes change in a mitered elbow, use single wall type vanes with a trailing edge extension.
   5. Turing vanes for Ducts with air velocity greater than 2500 FPM: Use double wall type vanes (4-1/2” radius, 3-1/4” spacing).

3.02 TESTING

A. General: Check installed ductwork accessories for required operation and leak-proof performance during the system’s operational test. Repair or replace faulty accessories, as required to obtain proper operation and leak-proof performance.

END OF SECTION 23 33 00
SECTION 23 34 00
FANS AND HOODS

PART 1 - GENERAL

1.01 SUMMARY
A. The General Provisions, Supplemental General Provisions, section 23 01 00, Division 1 Specifications and Special Provisions apply to all Work specified in this Section.

B. This section describes the basic materials and installation methods for the fan and hood systems. Comply with other Division 23 sections and drawings as applicable. Refer to other divisions for coordination of work.

C. Furnish and install all components of the fan and hood systems specified herein, as indicated on the drawings, and as required to provide complete and operating systems.

1.02 DESCRIPTION OF WORK
A. Work Included: Provide U.L. listed fans and ventilators as required by code and as specified.

1.03 QUALITY ASSURANCE
A. Basis of design is Greenheck. Other acceptable manufacturers are ACME, Buffalo, Carnes, Cook, Penn, and Woods.

PART 2 - PRODUCTS

2.01 PRODUCT REQUIREMENTS
A. Ratings: Fans shall be licensed to bear the AMCA certified ratings seal. Ratings of fans shall be based on 70°F and 29.92" of Hg atmospheric pressure. Air handling equipment shall be sized in conformance with applicable codes and good engineering practice. Roof-mounted units shall be located in coordination with the Architect to ensure proper sight lines.

B. Construction: Fan construction shall be in accordance with AMCA classes of construction for the intended duty. Fan wheels, shafts, and drives shall be statically and dynamically balanced at the factory as a unit. Balance reports shall be factory-certified to the Construction Manger.

C. Drives: Provide drives with a minimum belt horsepower capacity of 120% of the motor nameplate horsepower.

D. Motor Sheaves: Motor sheaves shall be Browning Type, MVP, or approved equal, adjustable type with double-locking feature. Motor sheaves shall be selected for the rated fan rpm and shall be adjustable to as close as 10% above and below the rated fan speed.

E. Fan Sheaves: Provide adjustable or nonadjustable sheaves with removable machined bushings. Sheaves shall be machined on surfaces. Sheaves with over three grooves shall be dynamically balanced and the manufacturer shall so designate on each sheave. Fan sheaves with three grooves or less shall be statically balanced and weights required for balancing shall be welded to the sheaves. Manufacturers shall be Browning, Eaton,
Yale, Towne, Dodge Manufacturing Company, or Fort Worth Steel and Machinery Company.

F. **Belts:** Provide standard "V-groove" belts suitable for the service intended with the required capacities. The belts shall be closely matched and tagged prior to delivery to the job site. If the belts do not appear to be properly matched during operation, they shall be rechecked and, if necessary, replaced. Belts shall be as manufactured by Gates, Durkee-Atwood, Goodyear, Browning, or Uniroyal.

G. **Bearings:** Provide SKF, Sealmaster, Timken, or Fafnir externally or internally-mounted, grease-lubricated, self-aligning ball bearings. Bearings shall have grease type zerk fittings.

H. **Motor Mount:** Motors shall be mounted on an adjustable base rigidly supported on the fan and shall have extended shaft to accommodate the adjustable pitch sheave.

### 2.02 CENTRIFUGAL FANS

A. **General:** Provide centrifugal fans of the single-width, single-inlet type with either forward or backward curved fan blades, and adjustable belt drives.

B. **Motors:** Provide standard drip-proof motors.

C. **Fan:** Blades shall be die cut, die-formed, and hubs shall be machined close-grained cast iron. Steel housings shall have lock-seam construction with discharge reinforcement and shall be adjustable with continuous inlet collars. Provide weatherproof enclosure for motors and drive, if units are exposed to weather.

### 2.03 GREASE EXHAUST FANS

A. **General:** Fan shall be a spun aluminum, side wall mounted, direct drive, upblast centrifugal exhaust ventilator, specifically designed and tested for use in applications requiring the exhaust of grease laden air.

B. **Certifications:** Fan shall be manufactured at an ISO 9001 certified facility. Fan shall be listed by Underwriters Laboratories (UL 705) and UL listed for Canada (cUL 705). Fan shall bear the AMCA certified ratings seal for sound and air performance.

C. **Construction:** The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 16 gauge marine alloy aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have a one piece inlet spinning and continuously welded curb cap corners for maximum leak protection. The windband shall have a rolled bead for added strength. A two piece top cap shall have stainless steel quick release latches to provide access into the motor compartment without the use of tools. An integral conduit chase shall be provided into the motor compartment to facilitate wiring connections. The motor, bearings and drives shall be mounted on a minimum 14 gauge steel power assembly, isolated from the unit structure with rubber vibration isolators. These components shall be enclosed in a weather-tight compartment, separated from the exhaust airstream. Lifting lugs shall be provided to help prevent damage from improper lifting. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design CFM, static pressure, and maximum fan RPM. Unit shall be shipped in ISTA certified transit tested packaging.
D. Wheel: Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204-96, Balance Quality and Vibration Levels for Fans.

E. Motor: Motor shall be heavy duty type with permanently lubricated sealed ball bearings and furnished at the specified voltage, phase and enclosure.

F. Bearings: Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy duty re-greasable ball type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.

G. Belts & Drives: Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150 percent of the installed motor horsepower. The variable pitch motor drive must be factory set to the specified fan RPM.

H. Grease Capture: Provide with grease capture and containment system.

PART 3 - EXECUTION

3.01 VENTILATION AND EXHAUST FANS

A. General: Ventilating and exhaust fans not having integral vibration isolation shall be mounted on or suspended by vibration isolators as specified under Section 23 05 48. Where ductwork is connected to fans, Contractor shall provide UL labeled flexible duct connections.

B. Curbs: Factory-fabricated roof curbs, caps, and similar items, shall be supplied and installed by Mechanical Contractor. Coordinate installation with Roofing Contractor.

3.02 SYSTEMS

A. Refer to Section 23 05 53, "Mechanical Identification" for applicable painting, nameplate, and labeling requirements.

B. Placement of fans and noise levels generated by the fans shall be taken into consideration. Refer to specification 23 34 00 for additional information.

END OF SECTION 23 34 00
SECTION 23 37 00
REGISTERS, GRILLES, AND DIFFUSERS

PART 1 - GENERAL

1.01 SUMMARY

A. The General Provisions, Supplemental General Provisions, section 23 01 00, Division 1 Specifications and Special Provisions apply to all Work specified in this Section.

B. This section describes the basic materials and installation methods for the registers, grilles, and diffusers. Comply with other Division 23 sections and drawings as applicable. Refer to other divisions for coordination of work.

C. Furnish and install all components of the registers, grilles, and diffusers specified herein, as indicated on the drawings, and as required to provide complete and operating systems.

1.02 DESCRIPTION OF WORK

A. Work Included: Provide air outlets and inlets as required for the finished areas of the project including the following:
   1. Ceiling air registers, grilles, diffusers
   2. Wall mounted registers and grilles
   3. Linear lay-in slot diffusers
   4. Architectural linear diffusers

1.03 QUALITY ASSURANCE

A. Basis of design is Titus. Other acceptable manufacturers are Krueger, Anemostat, Carnes, Metal Aire, Price, or Tuttle & Bailey.

B. NFPA Compliance: Comply with NFPA 90, as applicable to air diffuser construction and installation.

C. Air Distribution Equipment: Maximum space temperature variation shall not exceed 2°F through the conditioned area from 2’ above the floor to 7’ above the floor. The air outlets shall be selected by the manufacturer to suit the volume, throw, and noise level criteria described in these Specifications, and maintain maximum terminal velocities of 50 fpm, unless otherwise indicated.

PART 2 - PRODUCTS

2.01 AIR OUTLETS AND INLETS

A. General: Provide air outlets and inlets of the size, shape, and type, constructed of materials and components, and with finishes as required. Apply corrosion resistant treatment to surfaces prior to applying prime coat.

B. Ceiling Diffusers: Provide diffusers with corrosion resistant treated surfaces and finished in baked enamel unless otherwise required. Where applicable, provide adapters with diffusers to permit connection to round supply duct.

C. Registers and Grilles:
1. General: Provide registers that contain a key-operated multi-louvered opposed blade damper operable from the face side.
2. Supply Air Register: Provide supply air registers of the double deflection type.
3. Return Air Grilles and Return Air Registers: Provide grilles and registers as required.

D. Supply Linear Diffuser:
1. Provide supply linear diffuser with length and width as required. The supply diffuser shall be installed above the ceiling and located as indicated on the Architectural and Mechanical Drawings.
2. The diffuser shall be designed, tested, and constructed in a manner so as to comply with the performance criteria and sound level requirements specified elsewhere in these Specifications. Plenum shall be constructed of at least 24 gauge galvanized steel and shall be reinforced as required. The air volume, length and duct connection size shall be as required. Coordinate the attachment, support, and similar features of the supply plenum with the ceiling Subcontractor.
3. The plenum shall be painted flat black on interior surfaces and the exposed surfaces as viewed from below the ceiling system shall be painted flat black.
4. Provide remote mounted balancing damper adjustment device similar to Young's Regulator.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General: Install air outlets and inlets in accordance with manufacturer's written instructions and recognized industry practices to ensure that products serve intended functions.

B. Duct Connection to Diffuser:

1. Where flexible duct is connected to ceiling diffusers, the contractor shall use one of these three methods:
   a. Insulated flexible duct with Titus FlexRight flexible duct support, UL listed, to form duct elbow.
   b. A sheet metal elbow externally insulated.
   c. Insulated flexible metal duct consisting of flexible metal core of corrugated aluminum with external insulation.

2. In all cases duct connection/elbow shall be made with a bend that has not less than one duct diameter centerline radial.

C. Coordination: Coordinate with other trades, including ductwork, and ductwork accessories, as necessary to interface air outlets and inlets properly with other work.

3.02 FIELD CONTROL QUALITY CONTROL

A. Test installed devices to demonstrate satisfactory compliance with specified and indicated requirements.

END OF SECTION 23 37 00
SECTION 23 74 33

PACKAGED DIRECT – EXPANSION GAS – FIRED 100% OUTSIDE AIR UNIT

PART 1 – GENERAL

1.01 SUMMARY

A. This section includes units with integral heating and cooling for rooftop installation. Integral heat source shall be Indirect Gas-Fired furnace. Integral cooling source shall be packaged DX. Airflow arrangement shall be Outdoor Air only. Each unit shall be constructed in a horizontal configuration and shall incorporate additional product requirements as listed in Section 2 of this specification.

B. Related sections include the following:
   1. Section 22 01 00: General Plumbing Requirements
   2. Section 22 07 00: Plumbing Insulation
   3. Section 22 10 00: Plumbing Piping
   4. Section 26 00 00: Electrical

1.02 SUBMITTALS

A. Product Data: For each type or model include the following:
   1. Complete fan performance curves for Supply and Exhaust Air, with system operating conditions indicated, as tested on an AMCA Certified Chamber.
   2. Sound performance data for Supply Air, as tested on an AMCA Certified chamber.
   3. Motor ratings, electrical characteristics and motor and fan accessories.
   4. Performance ratings for all chilled water or DX coils.
   5. Dimensioned drawings for each type of installation, showing isometric and plan views, to include location of attached ductwork and service clearance requirements.
   6. Estimated gross weight of each installed unit.
   7. Installation, Operating and Maintenance manual (IOM) for each model.
   8. Microprocessor Controller (DDC) specifications to include available options and operating protocols. Include complete data on all factory-supplied input devices.
   9. AHRI Certified coil performance ratings with system operating conditions indicated. Ratings shall be in accordance with Standard 410.
   10. Color chart including a palette of available standard paint finishes.

1.03 QUALITY ASSURANCE

A. Source Limitations: Obtain unit with all appurtenant components or accessories from a single manufacturer.
B. For the actual fabrication, installation, and testing of work under this section, use only thoroughly trained and experienced workers completely familiar with the items required and with the manufacturer's current recommended methods of installation.
C. Product Options: Drawings must indicate size, profiles and dimensional requirements of Energy Recovery Unit and are to be based on the specific system indicated. Refer to Division 1 Section “Product Requirements”.
D. Certifications
   1. Blowers shall be AMCA Certified for air flow.
   2. Entire unit shall be ETL Certified per U.L. 1995 and bear an ETL sticker.
   3. Coils shall be Recognized Components for ANSI/UL 1995, CAN / CSA C22.2 No 236.05. DX coils shall be AHRI Certified per standard 410-2001.
4. Indirect gas-fired furnace shall be ETL certified as a component of the unit.

1.04 COORDINATION

A. Coordinate size and location of all building penetrations required for installation of each unit and associated plumbing and electrical systems.

B. Coordinate location of water system fittings to ensure correct positioning for connection to the condensate drain pipe.

C. Coordinate sequencing of construction of associated plumbing, HVAC, electrical supply, and roofing contractor.

1.05 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. Filters: Two sets of MERV 8 (pre-filter) and MERV 13 (final filter) disposable filters for each unit.
   2. One set of fan belts.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with specifications contained within this document, manufacturers offering products that may be incorporated into the work include, but are not limited to:
   1. Greenheck Fan Corporation
   2. Daiken
   3. Munters
   4. Trane
   5. Addison

2.02 MANUFACTURED UNITS

A. Unit shall be fully assembled at the factory and consist of an insulated metal cabinet, downturn outdoor air intake with metal mesh filter assembly, evaporator coil, condensate drain pan, P trap, hot gas reheat coil, indirect gas furnace, packaged DX system, phase and brownout protection, motorized dampers, sensors, curb assembly, service receptacle, filter assembly for intake air, supply air blower assembly and an electrical control center. All specified components and internal accessories factory installed are tested and prepared for single-point high voltage connection.

2.03 CABINET

A. Materials: Formed, double wall insulated metal cabinet, fabricated to permit access to internal components for maintenance.
   1. Outside casing: 18 gauge, galvanized (G90) steel meeting ASTM A653 for components that do not receive a painted finish. Pre-painted components as supplied by the factory shall have polyester urethane paint on 18 gauge G60 galvaneal steel. Components that receive a painted finish per A/E specification shall be of 18 gauge type A60 galvaneal steel and shall be painted with a baked industrial enamel finish. Components that receive a painted finish per A/E specification shall be painted with a polyester urethane powder coat.
   2. Internal assemblies: [24 gauge, galvanized (G90) steel] except for motor supports which shall be minimum 14 gauge galvanized (G90) steel.

B. Cabinet Insulation: Comply with NFPA 90A and NFPA 90B and erosion requirements of UL 181.
1. Materials: Fiberglass insulation. If insulation other than fiberglass is used, it must also meet the Fire Hazard Classification shown below.
   a) Thickness: 2 inch (50 mm)
   b) Fire Hazard Classification: Maximum flame spread of 25 and smoke developed of 50, when tested in accordance with ASTM C 411.

C. Access panels / doors: Unit shall be equipped with insulated, hinged doors or removable access panels to provide easy access to all major components. Doors and access panels shall be fabricated of 18 gauge galvanized G90 steel or painted galvannealed steel.

D. Supply Air blower assemblies: Blower assembly shall consist of an electric motor and a direct-drive fan. Assembly shall be mounted on heavy gauge galvanized steel rails and further mounted on 1.125 inch thick neoprene vibration isolators. Blower motor shall be capable of continuous speed modulation and controlled by a VFD.

E. Evaporator Coil: Evaporator coil shall be AHRI Certified and shall be (silver) soldered or brazed into the compressed refrigerant system. Coil shall be constructed of copper tubing, permanently bonded to aluminum fins and enclosed in a galvanized steel frame. If two compressors are used as components of the unit, then the evaporator coil shall be of “interlaced” configuration, permitting independent operation of either compressor without conflict with the other compressor.

F. Control panel / connections: Rooftop Ventilator units shall have an electrical control center where all high and low voltage connections are made. Control center shall be constructed to permit single-point high voltage power supply connections. RTU shall be equipped with a Unit Disconnect Switch.

G. Condensate drain pan: Drain Pan shall be an integral part of the unit whenever a cooling option is included. Pan shall be formed of welded austenitic stainless steel sheet material and provided with a welded stainless steel drain connection at the front for connection to a P trap. Drain pan shall be sloped in two directions to provide positive draining and drain connector shall be sealed at penetration through cabinet wall.

H. P trap: If the unit is equipped with a condensate drain pan, contractor shall provide, or fabricate, and install an appropriate P trap, in accordance with all local and area codes and Best Practices.

I. Reheat Coil with factory installed modulating hot gas reheat valve.

J. Indirect gas furnace:
   1. Shall be ETL Certified as a component of the unit.
   2. Shall have an integral combustion gas blower.
   3. Shall be ETL Certified for installation downstream of a cooling coil.
   4. Shall have fault sensors to provide fault conditions to optional digital controller or building controls.
   5. Shall have 4-pass tubular heat exchangers, constructed of type 409 stainless steel. Heat exchanger tubes shall be installed on the vest plate by means of swaged assembly, welded connections are not acceptable. Heat exchanger tubes shall be supported by a minimum of two fabricated assemblies that support the tubes and also permit expansion and contraction of the tubes.
   6. Heat exchanger shall have a 10 year extended warranty.
   7. Furnace control shall be 12:1 Modulating
   8. Shall be encased in a weather-tight metal housing with intake air vents. Large, metal lift-off door shall provide easy access to the enclosed vest plate, control circuitry, gas train, burner assembly and exhaust blower.
   9. Shall have solid state controls permitting stand-alone operation or control by building controllers.
K. Packaged DX System: unit shall have an integral compressor(s) and evaporator coil located within the weather-tight unit housing. Condenser coils and appurtenant condenser fan assemblies shall be factory installed as integral subassemblies of the unit and mounted on the exterior of the unit. Condenser fan motors shall be three phase, type 56 frame, Open Air Over and Shaft Up. Each condenser fan motor shall have a vented frame, rated for continuous duty and be equipped with an automatic reset thermal protector. Motors shall be UL Recognized and CSA Certified. The refrigerant compressor(s) shall be [digital] hermetic scroll-type and shall be equipped with liquid line filter drier, thermostatic expansion valves (TXV)(s), manual reset high pressure and low pressure cutouts and all appurtenant sensors, service ports and safety devices. Compressed refrigerant system shall be fully charged with R-410A refrigerant. Each compressor shall be factory-equipped with an electric crankcase heater to boil off liquid refrigerant from the oil.

L. Packaged DX Control and Diagnostics: The Packaged DX system shall be controlled by an onboard digital controller (DDC) that indicates both owner-supplied settings and fault conditions that may occur. The DDC shall be programmed to indicate the following faults:
1. Global alarm condition (active when there is at least one alarm)
2. Supply Air Proving alarm
3. Dirty Filter Alarm
4. Compressor Trip alarm
5. Compressor Locked Out alarm
6. Supply Air Temperature Low Limit alarm
   a) Sensor #1 Out of Range (outside air temperature)
   b) Sensor #2 Out of Range (supply air temperature)
   c) Sensor #3 Out of Range (cold coil leaving air temperature)

M. Phase and brownout protection: RTU shall have a factory-installed phase monitor to detect electric supply phase loss and voltage brown-out conditions. Upon detection of a fault, the monitor shall disconnect supply voltage to all motors.

N. Motorized dampers / Intake Air: Motorized damper of low leakage type shall be factory installed.

O. Sensors are considered to be part of various optional operational modes or device controllers and are to be factory supplied and installed.

P. Curb Assembly: A curb assembly made of 14 gauge galvanized steel shall be provided by the factory for assembly and installation as part of this division. The curb assembly shall provide perimeter support of the entire unit and shall have duct adapter(s) for supply air. Curb assembly shall enclose the underside of the unit and shall be sized to fit into a recess in the bottom of the unit. Contractor shall be responsible for coordinating with roofing contractor to ensure curb unit is properly flashed to provide protection against weather/moisture penetration. Contractor shall provide and install appropriate insulation for the curb assembly. The curb shall be the height of 14”.

Q. Service receptacle: 120 VAC GFCI service outlet shall be factory-provided and installed by this contractor in a location designated by the A/E.

R. Hail guards: Protects the condensing unit from damage due to extreme weather conditions such as hail and flying debris.

S. Vapor Tight Lights: Provide service lights mounted in the unit to be used during times of routine maintenance. The lights must be wired by others on the jobsite, as they will not be wired through the unit control center.

T. 24V/120V Smoke detector – Duct smoke detector is shipped loose for field mounting and wiring in the supply or return air duct. The air duct smoke detector housing shall be UL listed per UL 268A specifically for use in air handling systems. The air duct smoke detector housing shall be suitable for mounting indoors. The detector shall operate at air velocities of 100 feet per minute.
to 4000 feet per minute (0.5 to 20.32 meters/second). The power supply voltage shall be 20-29 VDC, 24 VAC 50-60 Hz, and 120 VAC 50-60 Hz. The detector shall consist of an alarm initiation contact & two DPDT auxiliary contact closures.

2.04 BLOWER

A. Blower section construction, Supply Air: direct drive motor and blower shall be assembled on a 14 gauge galvanized steel platform and shall be equipped with 1.125 inch thick neoprene vibration isolation devices.

B. Blower assemblies: Shall be statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower.

C. Fan: Airfoil plenum fan statically and dynamically balanced, AMCA certified for air and sound performance, mounted on ground and polished steel fan shafts with ball bearing pillow blocks. Bearings shall be selected for a minimum L10 life in excess of 50,000 hours at maximum catalogued speeds.

D. Blower section motor source quality control: Blower performance shall be factory tested for flow rate, pressure, power, air density, rotation speed and efficiency. Ratings are to be established in accordance with AMCA 210, “Laboratory Methods of Testing Fans for Rating.”

2.05 MOTORS

A. General: Blower motors greater than ¾ horsepower shall be “NEMA Premium™” unless otherwise indicated. Compliance with EPAct minimum energy-efficiency standards for single speed ODP and TE enclosures is not acceptable. Motors shall be heavy-duty, permanently lubricated type to match the fan load and furnished at the specified voltage, phase and enclosure. Motors shall be 60 cycles, 3 phase 280 volt.

2.06 UNIT CONTROLS

A. The unit shall be constructed so that it can function as a stand-alone heating and cooling system controlled by factory-supplied controllers, thermostats and sensors or it can be operated as a heating and cooling system controlled by a VRF Control System. This unit shall be controlled by a factory-installed microprocessor programmable controller (DDC) that is connected to various optional sensors. Contractor shall verify unit is capable of being integrated in to VRF manufacturer’s software. If not contractor shall provide all necessary software or communicating devices to allow unit integration.

B. Unit shall incorporate a DDC controller with integral LCD screen that provides text readouts of status. DDC controller shall have a built-in keypad to permit operator to access read-out screens without the use of ancillary equipment, devices or software. DDC controllers that require the use of equipment or software that is not factory-installed in the unit are not acceptable. Alarm readouts consisting of flashing light codes are not acceptable. Owner-specified ventilating conditions can be input by means of pushbuttons.

C. RTU supply fan shall be configured for Constant Volume (ON / OFF) network control, duct pressure by factory, 0 – 10 VDC by others to DDC.

D. Outside Air damper control shall be field adjustable two-position, network control.

E. Economizer control shall be temperature, temperature / dew point.

F. Dirty filter sensor shall be factory-installed.

G. Operating protocol: The DDC shall be factory-programmed for BACnet.
H. Variable Frequency Drive (VFD) unit shall have factory installed variable frequency drive for modulation of the supply air blower assembly. The VFD shall be factory-programmed for unit-specific requirements and shall not require additional field programming to operate.

I. Airflow monitoring

2.07 FILTERS

A. Unit shall have permanent metal filters located in the outdoor air intake and shall be accessible from the exterior of the unit. MERV 8 disposable pleated filters shall be provided in the supply air stream. MERV 8 and MERV 13 disposable pleated filters shall be provided in the supply final air stream.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Prior to start of installation, examine area and conditions to verify correct location for compliance with installation tolerances and other conditions affecting unit performance. See unit IOM.

B. Examine roughing-in of plumbing, electrical and HVAC services to verify actual location and compliance with unit requirements. See unit IOM.

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

3.02 INSTALLATION

A. Installation shall be accomplished in accordance with these written specifications, project drawings, manufacturer’s installation instructions as documented in manufacturer’s IOM, Best Practices and all applicable building codes.

3.03 CONNECTIONS

A. In all cases, industry Best Practices shall be incorporated. Connections are to be made subject to the installation requirements shown above.
   1. Piping installation requirements are specified in Division 22 (Plumbing). Drawings indicate general arrangement of piping, fittings and specialties.
   2. Duct installation and connection requirements are specified in Division 23 of this document.
   3. Electrical installation requirements are specified in Division 26 of this document.

3.04 FIELD QUALITY CONTROL

A. Manufacturer’s Field Service: Engage a factory authorized service representative to inspect field assembled components and equipment installation, to include electrical and piping connections. Report results to A/E in writing. Inspection must include a complete startup checklist to include (as a minimum) the following: Completed Start-Up Checklists as found in manufacturer’s IOM.

3.05 START-UP SERVICE

A. Engage a factory authorized service representative to perform startup service. Clean entire unit, comb coil fins as necessary, and install clean filters. Measure and record electrical values for voltage and amperage. Refer to Division 23 “Testing, Adjusting and Balancing” and comply with provisions therein.

3.06 DEMONSTRATION AND TRAINING
A. Engage a factory authorized service representative to train owner's maintenance personnel to adjust, operate and maintain the entire unit. Refer to Division 01 Section Closeout Procedures and Demonstration and Training.

END OF SECTION 23 74 33
SECTION 23 81 26
AIR COOLED SPLIT SYSTEM AIR CONDITIONING UNITS

PART 1 - GENERAL

1.01 SUMMARY
A. The General Provisions, Supplemental General Provisions, section 23 01 00, Division 1 Specifications and Special Provisions apply to all Work specified in this Section.
B. This section describes the basic materials and installation methods for the packaged direct expansion variable air volume rooftop air conditioning units. Comply with other Division 23 sections and drawings as applicable. Refer to other divisions for coordination of work.
C. Furnish and install all components of the rooftop units specified herein, as indicated on the drawings, and as required to provide complete and operating systems.

1.02 DESCRIPTION OF WORK
A. Work Included: Provide a UL listed split system air-conditioning unit work including, but not limited to, the furnishing and installation of an indoor evaporator unit, an air-cooled condensing unit, filters, thermostat, accessories and other controls as required by local, state, and other applicable codes.

1.03 QUALITY ASSURANCE
A. Manufacturer: "Basis of Design" is Mitsubishi. Acceptable alternate manufacturers:
   1. Carrier
   2. Daikin

1.04 SUBMITTALS
A. Shop drawings submittals shall include, but are not limited to, the following:
   1. Unit cut-sheets clearly showing all features, accessories, dimensions, weights and capacities.
   2. Written instructions for equipment to installation.
   3. Wiring and piping diagrams and connection locations.
   4. Performance certifications and test results.
   5. Warranty information.
   6. Additional information as required in Section 23 01 00.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING
A. Deliver split system air conditioning units and accessories in factory-fabricated water-resistant wrapping.
B. Handle split system air conditioning units and accessories carefully to avoid damage to material components, enclosure and finish.
C. Store split system air conditioning units and accessories in a clean, dry space and protect from the weather.
PART 2 - PRODUCTS

2.01 MATERIALS

A. General: Except as otherwise indicated, provide split system air-conditioning unit manufacturer's standard materials and components as indicated by his product information, designed and constructed as recommended by the manufacturer and as required for a complete installation.

B. Evaporator Units:
   1. General: Provide DX fan coil units of the size and capacity scheduled on the Drawings. All units shall be UL approved and rated in accordance with AIR Industry Standard 441.
   2. Basic Unit: Units shall be fabricated of 18 gauge galvanized steel. The fan and motor assembly shall be easily removable for service. Units shall have 1" supply and return duct collars.
   3. Cabinet: Cabinets shall be horizontal enclosed type and shall have 18 gauge steel panels acoustically and thermally insulated with 1/2" coated glass fiber insulation meeting NFPA-90A requirements. Exposed panels shall be bonderized and finished with a baked primer and a finish coat of enamel.
   4. Coils: DX cooling coils shall have copper tubes with aluminum fins, mechanically bonded to the tubes. Coils for use with single compressor condensing units shall be single circuit and coils for use with dual compressor condensing units shall have two full-face refrigerant circuits. A factory installed thermal expansion valve shall be provided for each circuit. "A" coils shall be factory leak tested at 225 psi air under water. Coils shall have a maximum of 12 fins per inch. Coil air pressure drop shall not exceed scheduled maximum.
   5. Electric Heat: Electric heating elements shall be integrally mounted and shall have voltage and capacity as scheduled. Heater elements shall be constructed of heavy-duty nickel chromium wire. Heaters shall be complete with magnetic contactor and all required controls and safeties.
   6. Motors: Motors shall be 3-speed, high efficiency, permanent split capacitor type with thermal overload protection. Maximum motor horsepower, input wattage shall not exceed that schedule.
   7. Junction Box: Units shall have a factory installed junction box with the fan motor and heating coil wired to the junction box.
   8. Fans: Fans shall be of the centrifugal, forward-curved type. Fan wheels shall be statically and dynamically balanced. Fan wheels and housings shall be galvanized steel.
   9. Drain Pan: Pans shall be fabricated of 18 gauge galvanized steel lined on the interior surfaces with 1/2" fire retardant closed cell foam. A 7/8" OD sweat fitting shall be provided for primary drain connection. A 1/2" OD overflow secondary drain connection shall be provided. Units shall be provided with a pan extension under the piping area.
   10. Filters: Filter shall be 1" throwaway of woven glass fiber and shall be installed in each unit. RA opening shall be a [rear] [bottom] mounted grill or duct connection as shown on the drawings. Three sets of filters shall be supplied for each fan coil units. One set shall be installed at initial unit startup after all ductwork has been blowout and shall be used during balancing and testing, the second set shall be installed at the time of substantial completion and the third set shall be turned over to the Owner. Any additional filter sets required during the construction period shall be the responsibility of the Contractor.
   11. Certification: All fan coil unit performance data shall be certified in accordance with AIR 441-70. Units shall be sound-tested and rated in accordance with ARI-443-70.
   12. Unit Controls: Controls shall include a magnetic fan contractor, terminal strip, heater contactor and controls, and all other required controls. All controls shall be factory wired and tested.
C. Duct Mounted DX Cooling Coils:
   1. General: Provide duct mounted DX cooling coils of the size, type, capacity and arrangement as shown and scheduled on the Drawings.
   2. Coils: Coils shall consist of aluminum plate fins mechanically bonded to copper tubes. Coils for use with single compressor condensing units shall be single circuit and coils for use with dual compressor condensing units shall have two full-face refrigerant circuits. A factory installed thermal expansion valve shall be provided for each circuit. Coils shall be factory leak tested at 225 psi air under water. Coils shall have a maximum of 12 fins per inch. Coil air pressure drop shall not exceed scheduled maximum and the coil shall be selected to match the condensing unit that serves it.
   3. Casing: The coil shall be encased in a painted galvanized enclosure with an integral drain pan with primary and auxiliary drain connections. The casing shall have refrigerant line connections and duct flange connections as required.
   4. Auxiliary Drain Pan: An auxiliary drain pan shall be installed under each duct mounted cooling coil.

D. Air-cooled Condensing Units:
   1. General: Provide air cooled condensing units of the size, type, capacity and arrangement as shown and scheduled on the Drawings. Condensing units shall be assembled on a heavy-gauge integral steel base. Units shall be weatherproofed and include hermetic compressor(s), condensing coils, fans and motors, controls and holding charge of R-22. Units shall have a control box access panel and removable end panels that allow access to all major components and controls.
   2. Unit Frame: Frame shall be a welded assembly of heavy gauge zinc-coated, galvanized steel. Drainage holes shall be provided as required. Exterior surfaces shall be cleaned, phosphatized and coated with an epoxy resin primer and finished with an enamel finish.
   3. Refrigeration Circuits: Units up to 7-1/2 tons shall have single compressors with a single compressor. Units 10 tons and larger shall have dual compressors and dual refrigerant circuits for use with a dual circuit cooling coil. Each refrigeration circuit shall have an integral sub-cooling circuit.
   4. Compressors: Each compressor shall be a direct-drive hermetic type with centrifugal oil pump; two-point lubrication for each bearing and connecting rod; crankcase heater and well; high strength, ring-type suction and discharge valves; large gas passages and minimum clearance volumes; and rubber-in-shear isolators; and a thermostatically controlled crankcase heater.
   5. Compressor Motors: Each compressor motor shall be suction gas-cooled and have a voltage utilization range of plus or minus 10 percent of nameplate voltage. Internal temperature and current-sensitive motor overloads shall protect compressors under loss of charge and other abnormal operating conditions.
   6. Condenser Fans: Fans shall be vertical discharge, direct-drive type, statically and dynamically balanced, with aluminum blades and zinc-plated steel hubs. Motors shall have permanently lubricated ball bearings, built-in current and thermal overload protection and weather-tight slingers over bearings. The fan motors shall be mounted in rubber isolators. Corrosion resistant fan grills shall be provided.
   7. Condenser Coils: Condenser coils shall be aluminum fins mechanically bonded to seamless copper tubing. Sub-cooling circuit(s) shall be provided as standard for each refrigeration circuit. Coils shall be factory pressure and leak-tested to 425 psig air pressure. Corrosion resistant metal grilles for coil protection shall be provided.
   8. Controls: Unit controls shall include a fused 24-volt control power transformer, magnetic contactors for each compressor, cooling low ambient fan switches, high pressure cut-out(s), low pressure cut-out(s) and reset relays. Unit completely factory-wired with necessary controls and terminal block for connection of field control power wiring. An anti-recycle timer shall be provided. Provide low ambient controls, as scheduled.
9. Refrigerant/Oil Charge: Units shall be shipped from the factory with a sufficient charge of refrigerant and oil for the complete system when used with pre-charged refrigerant lines.

10. Refrigerant Line Connections: Connections shall be either compression or sweat type. Brass liquid and suction line service valves, gauge/charging ports in the liquid line and a sight glass in the liquid line shall be provided.

11. Low Ambient Operation: Units shall include head pressure controller dampers, fan speed control or hot gas bypass as required to allow starting and operation down to 0 °F.

12. Warranty: The manufacturer's one year parts and labor and five year extended (non pro-rated) compressor warranty shall be provided.

PART 3 – EXECUTION

3.01 INSTALLATION

A. General: Install each computer room air conditioning system in accordance with manufacturer's instructions, the NEC, and applicable local codes and ordinances. Test installed system for compliance with these Specifications. Rework as required and as directed to ensure that specified and indicated requirements are met and that installed systems function as intended.

B. Mounting: Provide foundation, platforms, and hangers required for proper installation of equipment.

C. Fans: Install fans to operate without noticeable vibration or noise after installation.

D. Guards: Arrange belt guards to permit accessible tachometer readings, oiling, and testing with guards in position.

E. Refrigerant Piping: Install, test, evacuate and charge refrigerant piping per the manufacturer's recommendations and as specified in Section 15530, “Refrigerant Piping”. Technician performing this work shall be certified and shall utilize proper refrigerant reclaim procedures.

F. Identification: Refer to Section 23 05 53, “Equipment and Piping Identification”, for applicable painting, nameplate, and labeling requirements. Nameplates on units in finished areas shall be installed inside the unit cover and the unit manufacturers labeling system shall be used for exposed labeling of units.

END OF SECTION 23 81 26
Contractor Note: Any proprietary devices and controls contained in this specification shall not exclude the alternate manufacturer(s) from bidding as long as the alternate(s) meet or exceed the scheduled performance.

Contractor shall be responsible for the electrical connection requirements and modifications of the documents should an alternate manufacturer be selected.

PART 1 – General

1.01 SUMMARY

A. The General Provisions, Supplemental General Provisions, section 23 01 00, Division 1 Specifications and Special Provisions apply to all Work specified in this Section.

B. This section describes the basic materials and installation methods for the variable capacity, heat pump heat recovery air conditioning system. Comply with other Division 23 sections and drawings as applicable. Refer to other divisions for coordination of work.

C. Furnish and install all components of the variable capacity, heat pump heat recovery air conditioning system specified herein, as indicated on the drawings, and as required to provide complete and operating systems.

1.02 SYSTEM DESCRIPTION

The variable capacity, heat pump heat recovery air conditioning system shall be a Mitsubishi Electric CITY MULTI VRF (Variable Refrigerant Flow) zoning system.

1.03 QUALITY ASSURANCE

A. The units shall be listed by Electrical Testing Laboratories (ETL) and bear the ETL label.

B. All wiring shall be in accordance with the National Electrical Code (N.E.C.).

C. The units shall be manufactured in a facility registered to ISO 9001 and ISO14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).

D. All units must meet or exceed the 2010 Federal minimum efficiency requirements and the ASHRAE 90.1 efficiency requirements for VRF systems. Efficiency shall be published in accordance with the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standard 1230.

E. A full charge of R-410A for the condensing unit only shall be provided in the condensing unit.

1.04 DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled according to the manufacturer’s recommendation.

1.05 CONTROLS
A. The control system shall consist of a low voltage communication network of unitary built-in controllers with on-board communications and a web-based operator interface. A web controller with a network interface card shall gather data from this system and generate web pages accessible through a conventional web browser on each PC connected to the network. Operators shall be able to perform all normal operator functions through the web browser interface.

B. System controls and control components shall be installed in accordance with the manufacturer’s written installation instructions.

C. Furnish energy conservation features such as optimal start, night setback, request-based logic, and demand level adjustment of overall system capacity as specified in the sequence.

D. System shall provide direct and reverse-acting on and off algorithms based on an input condition or group conditions to cycle a binary output or multiple binary outputs.

E. Provide capability for future system expansion to include monitoring and use of occupant card access, lighting control and general equipment control (including 100% OA RTUs and exhaust fans).

F. System shall be capable of email generation for remote alarm annunciation.

G. Control system start-up shall be a required service to be completed by the manufacturer or a duly authorized, competent representative that has been factory trained in Mitsubishi Electric controls system configuration and operation. The representative shall provide proof of certification for Mitsubishi Electric Controls Applications Training indicating successful completion of no more than two (2) years prior to system installation. This certification shall be included as part of the equipment and/or controls submittals. This service shall be equipment and system count dependent and shall be a minimum of one (1) eight (8) hour period to be completed during normal working hours.

1.06 SUBMITTALS

A. Shop drawings submittals shall include, but are not limited to, the following:
   1. Unit cut-sheets clearly showing all features, accessories, dimensions, weight, and capacities.
   2. Written instructions for equipment to installation.
   3. Wiring and piping diagrams and connection locations.
   4. Performance certifications and test results.
   5. Warranty information.
   6. Additional information as required in Section 23 01 00.

PART 2 – Warranty

2.01 The CITY MULTI units shall be covered by the manufacturer’s limited warranty for a period of one (1) year parts and seven (7) year compressor to the original owner from date of installation.

If the systems are:

1) Designed by a certified CITY MULTI Diamond Designer using Diamond System Builder,
2) Installed by a contractor that has successfully completed the Mitsubishi Electric three day service course, AND
3) Verified with required materials submitted to and approved by the Mitsubishi Electric Service Department, which include:
   - As built Diamond System Builder file,
   - A one (1) hour Maintenance Tool record with system information, in Ordinary Control Mode (not initial),
   - Outdoor and Indoor unit dip switch settings
- Outdoor unit(s) function settings,

Then the units shall be covered by an extended manufacturer’s limited warranty for a period of ten (10) years to the original owner from date of installation.

In addition the compressor shall have a manufacturer’s limited warranty for a period of ten (10) years to the original owner from date of installation.

If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer.

This warranty shall not include labor.

2.02 Manufacturer shall have a minimum of twenty (20) years of HVAC experience in the U.S. market.

2.03 All manufacturer technical and service manuals must be readily available for download by any local contractor should emergency service be required. Registering and sign-in requirements which may delay emergency service reference are not allowed.

2.04 The CITY MULTI VRF system shall be installed by a contractor with extensive CITY MULTI install and service training. The mandatory contractor service and install training should be performed by the manufacturer.

PART 3 – Products

3.01 L-GENERATION R2-SERIES OUTDOOR UNIT

A. General:

The R2-Series PURY outdoor unit shall be used specifically with CITY MULTI VRF components. The PURY outdoor units shall be equipped with multiple circuit boards that interface to the M-NET controls system and shall perform all functions necessary for operation. Each outdoor unit module shall be completely factory assembled, piped and wired and run tested at the factory.

1. The model nomenclature and unit requirements are shown below. All units requiring a factory supplied twinning kits shall be piped together in the field, without the need for equalizing line(s). If an alternate manufacturer is selected, any additional material, cost, and labor to install additional lines shall be incurred by the contractor.

<table>
<thead>
<tr>
<th>Outdoor Unit Model Nomenclature</th>
<th>208/230 Volt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model Number</td>
<td>Units</td>
</tr>
<tr>
<td>PURY-P72TLMU</td>
<td>(1) PURY-P72TLMU</td>
</tr>
<tr>
<td>PURY-P96TLMU</td>
<td>(1) PURY-P96TLMU</td>
</tr>
<tr>
<td>PURY-P120TLMU</td>
<td>(1) PURY-P120TLMU</td>
</tr>
</tbody>
</table>
2. Outdoor unit shall have a sound rating no higher than 61 dB(A) individually or 64 dB(A) twinned. Units shall have a sound rating no higher than 51 dB(A) individually or 54 dB(A) twinned while in night mode operation. If an alternate manufacturer is selected, any additional material, cost, and labor to meet published sound levels shall be incurred by the contractor.

3. Both refrigerant lines from the outdoor unit to the BC (Branch Circuit) Controller (Single or Main) shall be insulated in accordance with the installation manual.

4. The outdoor unit shall have the capability of installing the main refrigerant piping through the bottom of the unit.

5. There shall be no more than 3 branch circuit controllers connected to any one outdoor unit.

6. Outdoor unit shall be able to connect to up to 50 indoor units depending upon model.

7. The outdoor unit shall have an accumulator with refrigerant level sensors and controls.

8. The outdoor unit shall have a high pressure safety switch, over-current protection, crankcase heater and DC bus protection.

9. The outdoor unit shall have the ability to operate with a maximum height difference of 164 feet and have total refrigerant tubing length of 1804-3100 feet. The greatest length is not to exceed 541 feet between outdoor unit and the indoor units without the need for line size changes or traps.

10. The outdoor unit shall be capable of operating in heating mode down to -4°F ambient temperatures or cooling mode down to 23°F ambient temperatures, without additional low ambient controls. If an alternate manufacturer is selected, any additional material, cost, and labor to meet low ambient operating condition and performance shall be incurred by the contractor.

11. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained. Unit must defrost all circuits simultaneously in order to resume full heating more quickly. Partial defrost which may extend "no or reduced heating" periods shall not be allowed.

B. Unit Cabinet:

1. The casing(s) shall be fabricated of galvanized steel, bonderized and finished. Units cabinets shall be able to withstand 960 hours per ASTM B117 criteria for seacoast protected models (−BS models)

C. Fan:

1. Each outdoor unit module shall be furnished with one direct drive, variable speed propeller type fan. The fan shall be factory set for operation under 0 in. WG external static pressure, but capable of normal operation under a maximum of 0.24 in. WG external static pressure via dipswitch.

2. All fan motors shall have inherent protection, have permanently lubricated bearings, and be completely variable speed.

3. All fan motors shall be mounted for quiet operation.

4. All fans shall be provided with a raised guard to prevent contact with moving parts.

5. The outdoor unit shall have vertical discharge airflow.

D. Refrigerant

1. R410A refrigerant shall be required for PURY-P-T/Y(S)KLU outdoor unit systems.
2. Polyolester (POE) oil shall be required. Prior to bidding, manufacturers using alternate oil types shall submit material safety data sheets (MSDS) and comparison of hygroscopic properties for alternate oil with list of local suppliers stocking alternate oil for approval at least two weeks prior to bidding.

E. Coil:

1. The outdoor Hexicoil™ heat exchanger shall be of zinc coated aluminum construction with turbulating flat tube construction.
2. The coil fins shall have a factory applied corrosion resistant blue-fin finish.
3. A stainless steel pipe connects the aluminum coil to copper piping.
4. The coil shall be protected with an integral metal guard.
5. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.
6. The outdoor coil shall include 4 circuits with two position valves for each circuit, except for the last stage.

F. Compressor:

1. Each outdoor unit module shall be equipped with one inverter driven scroll hermetic compressor. Non inverter-driven compressors, which cause inrush current (demand charges) and require larger wire sizing, shall not be allowed.
2. A crankcase heater(s) shall be factory mounted on the compressor(s).
3. The outdoor unit compressor shall have an inverter to modulate capacity. The capacity shall be completely variable with a turndown of 15%-5% of rated capacity, depending upon unit size.
4. The compressor will be equipped with an internal thermal overload.
5. The compressor shall be mounted to avoid the transmission of vibration.
6. Field-installed oil equalization lines between modules are not allowed. Prior to bidding, manufacturers requiring equalization must submit oil line sizing calculations specific to each system and module placement for this project.

G. Controls:

1. The outdoor unit shall have the capability of up to 8 levels of demand control for each refrigerant system

H. Electrical:

1. The outdoor unit electrical power shall be 208/230 volts, 3-phase, 60 hertz.
2. The outdoor unit shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz), 207-253V (230V/60Hz).
3. The outdoor unit shall be controlled by integral microprocessors.
4. The control circuit between the indoor units, BC Controller and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

3.02 BRANCH CIRCUIT (BC) CONTROLLERS FOR R2-SERIES SYSTEMS

A. General

The BC (Branch Circuit) Controllers shall include multiple branches to allow simultaneous heating and cooling by allowing either hot gas refrigerant to flow to indoor unit(s) for heating or subcooled liquid refrigerant to flow to indoor unit(s) for cooling. Refrigerant used for cooling must always be subcooled for optimal indoor unit LEV performance; alternate branch devices with no subcooling risk bubbles in liquid supplied to LEV and are not allowed.

The BC (Branch Circuit) Controllers shall be specifically used with R410A R2-Series systems. These units shall be equipped with a circuit board that interfaces to the M-NET controls system and shall
perform all functions necessary for operation. The unit shall have a galvanized steel finish. The BC Controller shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory. This unit shall be mounted indoors, with access and service clearance provided for each controller. The sum of connected capacity of all indoor air handlers shall range from 50% to 120% of rated capacity. The BC Controller shall be suitable for use in plenums in accordance with UL1995 ed 4.

B. BC Unit Cabinet:
1. The casing shall be fabricated of galvanized steel.
2. Each cabinet shall house a liquid-gas separator and multiple refrigeration control valves.
3. The unit shall house two tube-in-tube heat exchangers.

C. Refrigerant
1. R410A refrigerant shall be required.

D. Refrigerant Branches
1. All BC Controller refrigerant pipe connections shall be brazed or flared.

E. Refrigerant valves:
1. The unit shall be furnished with multiple branch circuits which can individually accommodate up to 54,000 BTUH and up to three indoor units. Branches may be twinned to allow more than 54,000 BTUH.
2. Each branch shall have multiple two-position valves to control refrigerant flow.
3. Service shut-off valves shall be field-provided/installed for each branch to allow service to any indoor unit without field interruption to overall system operation.
4. Linear electronic expansion valves shall be used to control the variable refrigerant flow.

F. Integral Drain Pan:
1. An Integral resin drain pan and drain shall be provided.

G. Electrical:
1. The unit electrical power shall be 208/230 volts, 1 phase, 60 Hertz.
2. The unit shall be capable of satisfactory operation within voltage limits of 187-228 (208V/60Hz) or 207-253 (230/60Hz).
3. The BC Controller shall be controlled by integral microprocessors.
4. The control circuit between the indoor units and outdoor units shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

3.03 PKFY (Wall Mounted) INDOOR UNIT

A. General:
The PKFY shall be a wall-mounted indoor unit section and shall have a modulating linear expansion device and a flat front. The PKFY shall be used with the R2-Series outdoor unit and BC Controller, Y-Series outdoor unit, or S-Series outdoor unit. The PKFY shall support individual control using M-NET DDC controllers.

B. Indoor Unit
The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory. Provide add alternate pricing for swapping these units to concealed ducted units with minimal ducting. These add alternate units will incorporate MERV 13 filtration.

C. Unit Cabinet:
1. All casings, regardless of model size, shall have the same white finish.
2. Multi directional drain and refrigerant piping offering four (4) directions for refrigerant piping and two (2) directions for draining shall be standard.
3. There shall be a separate back plate which secures the unit firmly to the wall.

D. Fan:
1. The indoor fan shall be an assembly with one or two line-flow fan(s) direct driven by a single motor.
2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
3. A manual adjustable guide vane shall be provided with the ability to change the airflow from side to side (left to right).
4. A motorized air sweep louver shall provide an automatic change in airflow by directing the air up and down to provide uniform air distribution.

E. Filter:
1. Return air shall be filtered by means of an easily removable, washable filter.
2. See section 3.03/B. Provide add alternate pricing for MERV 13 filtration in all ducted units.

F. 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. Both refrigerant lines to the PKFY indoor units shall be insulated in accordance with the installation manual.

G. Electrical:
1. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
2. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz)

H. Controls:
1. This unit shall use controls provided by Mitsubishi Electric Cooling & Heating to perform functions necessary to operate the system. Please refer to Part 4 of this guide specification for details on controllers and other control options.
2. The unit shall be able to control external backup heat.
3. The unit shall have a factory built in receiver for wireless remote control.
4. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
5. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.
6. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
7. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

3.04 PEFY-NMAU (CEILING-CONCEALED DUCTED) INDOOR UNIT

A. General:
The PEFY shall be a ceiling-concealed ducted indoor fan coil design that mounts above the ceiling with a 2-position, field adjustable return and a fixed horizontal discharge supply and shall have a modulating linear expansion device. The PEFY shall be used with the R2-Series outdoor unit and BC Controller, Y-Series outdoor unit, or S-Series outdoor unit. The PEFY shall support individual control using M-NET DDC controllers. The unit shall be suitable for use in plenums in accordance with UL1995 ed 4.
B. Indoor Unit.
The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

C. Unit Cabinet:
1. The unit shall be, ceiling-concealed, ducted.
2. The cabinet panel shall have provisions for a field installed filtered outside air intake.

D. Fan:
1. PEFY-NMAU models shall feature external static pressure settings from 0.14 to 0.60 in. WG.
2. The indoor unit fan shall be an assembly with one or two Sirocco fan(s) direct driven by a single motor.
3. The indoor fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings.
4. The indoor fan shall consist of three (3) speeds, High, Mid, and Low plus the Auto-Fan function
5. The indoor unit shall have a ducted air outlet system and ducted return air system.

E. Filter:
1. Return air shall be filtered by means of a standard factory installed return air filter.
2. Optional return filter box (rear or bottom placement) with high-efficiency filter shall be available for all PEFY indoor units. Provide add alternate pricing for MERV 13 filtration in all ducted units.

F. 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. Provide auxiliary drain pan with auto-shut off switch that alarms to VRF control system.
7. The condensate shall be gravity drained from the fan coil.
8. Both refrigerant lines to the PEFY indoor units shall be insulated in accordance with the installation manual.

G. Electrical:
1. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
2. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

H. Controls:
1. This unit shall use controls provided by Mitsubishi Electric Cooling & Heating to perform functions necessary to operate the system. Please refer to Part 5 of this guide specification for details on controllers and other control options.
2. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
3. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.
4. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
5. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.
3.05 PEFY-NMH(S)U (ALTERNATE HIGH STATIC OPTION), CEILING-CONCEALED DUCTED INDOOR UNIT

A. General:
The PEFY-NMH(S)U (Alternate High Static Option) unit shall be a ceiling concealed ducted indoor fan coil that mounts above the ceiling with a fixed rear return and a horizontal discharge supply, and shall have a modulating linear expansion device. The PEFY-NMH(S)U shall be used with the R2-Series outdoor unit and BC Controller, Y-Series outdoor unit, or S-Series outdoor unit. The PEFY-NMH(S)U shall support individual control using M-NET DDC controllers. PEFY-NMH(S)U models shall feature external static pressure settings up 1.00 in. WG. Units shall have the ability to control supplemental heat via connector CN24 or CN4F and a 12 VDC output. The unit shall be suitable for use in plenums in accordance with UL1995 ed 4.

B. Indoor Unit.
The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

C. Unit Cabinet:
1. The cabinet shall be ceiling-concealed, ducted.
2. The cabinet panel shall have provisions for a field installed filtered outside air intake.

D. Fan:
1. The indoor unit fan shall be an assembly with one or two Sirocco fan(s) direct driven by a single motor.
2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
3. The indoor unit shall have a ducted air outlet system and ducted return air system.

E. Filter:
1. Return air shall be filtered by a field-supplied filter.
2. Optional rear return filter box with long-life filter shall available for all PEFY-NMH(S)U-E indoor units. Provide add alternate pricing for MERV 13 filtration in all ducted units.

F. 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 condensate shall be gravity drained from the fan coil.
7. Both refrigerant lines to the PEFY indoor units shall be insulated in accordance with the installation manual.
8. Provide auxiliary drain pan with auto-shut off switch that alarms to VRF control system.

G. Electrical:
1. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
2. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

H. Controls:
1. This unit shall use controls provided by Mitsubishi Electric to perform functions necessary to operate the system. Please refer to Part 5 of this guide specification for details on controllers and other control options.
2. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.

3. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.

4. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.

5. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

### 3.06 DESIGN BASIS:

The HVAC equipment basis of design is Mitsubishi. Alternate manufacturers shall be: Daikin.

All bidders shall furnish the minimum system standards as defined by the scheduled capacities (total & sensible) with manufacturer specific de-rates included. These de-rates include (but are not limited to) line lengths, ambient conditions, and entering conditions. Each manufacturer must include a piping diagram with estimated line lengths, and de-rate factors for their indoor and outdoor units with their proposal to ensure the proposed equipment meets or exceeds scheduled capacities and project design.

### PART – CONTROLS

#### 4.01 OVERVIEW

**A. General:**

The CITY MULTI Controls Network (CMCN) shall be capable of supporting remote controllers, centralized controllers, an integrated web based interface, graphical user workstation, and system integration to Building Management Systems via BACnet® and LonWorks®.

#### 4.02 Electrical Characteristics

**A. General:**

The CMCN shall operate at 30VDC. Controller power and communications shall be via a common non-polar communications bus.

**B. Wiring:**

1. Control wiring shall be installed in a daisy chain configuration from indoor unit to indoor unit, to the BC controller (main and subs, if applicable) and to the outdoor unit. Control wiring to remote controllers shall be run from the indoor unit terminal block to the controller associated with that unit.

2. Control wiring for the Smart ME remote controller shall be from the remote controller to the first associated indoor unit (TB-5) M-NET connection. The Smart ME remote controller shall be assigned an M-NET address.

3. Control wiring for the Simple MA and Wireless MA remote controllers shall be from the remote controller (receiver) to the first associated indoor unit (TB-15) then to the remaining associated indoor units (TB-15) in a daisy chain configuration.

4. Control wiring for centralized controllers shall be installed in a daisy chain configuration from outdoor unit to outdoor unit, to the system controllers (centralized controllers and/or integrated web based interface), to the power supply.

5. The AE-200, AE-50, and EB-50GU centralized controller shall be capable of being networked with other AE-200, AE-50, and EB-50GU centralized controllers for centralized control.
C. Wiring type:
   1. Wiring shall be 2-conductor (16 AWG), twisted, stranded, shielded wire as defined by the Diamond System Builder output.
   2. Network wiring shall be CAT-5 with RJ-45 connection.

4.03 CITY MULTI Controls Network

The CITY MULTI Controls Network (CMCN) consists of remote controllers, centralized controllers, and/or integrated web based interface communicating over a high-speed communication bus. The CITY MULTI Controls Network shall support operation monitoring, scheduling, occupancy, error email distribution, personal web browsers, tenant billing, online maintenance support, and integration with Building Management Systems (BMS) using either LonWorks® or BACnet® interfaces. The below figure illustrates a sample CMCN System Configuration.

![CMCN System Configuration Diagram]

A. CMCN: Remote Controllers Backlit Simple MA Remote Controller (PAC-YT53CRAU)

The Backlit Simple MA Remote Controller (PAC-YT53CRAU) shall be capable of controlling up to 16 indoor units (defined as 1 group). The Backlit Simple MA Remote Controller shall be compact in size, approximately 3” x 5” and have limited user functionality. The Backlit Simple MA supports temperature display selection of Fahrenheit or Celsius. The Backlit Simple MA Remote Controller shall allow the user to change on/off, mode (cool, heat, auto (R2/WR2-Series only), dry, setback (R2/WR2-Series only) and fan), temperature setting, and fan speed setting and airflow direction. The Backlit Simple MA Remote Controller shall be able to limit the set temperature range from the Backlit Simple MA. The Backlit Simple MA Remote controller shall be capable of night setback control with upper and lower set temperature settings. The room temperature shall be sensed at either the Backlit Simple MA Remote Controller or the Indoor Unit dependent on the indoor unit dipswitch setting. The Backlit Simple MA Remote Controller shall display a four-digit error code in the event of system abnormality/error.
The Backlit Simple MA Remote Controller shall only be used in same group with Wireless MA Remote Controllers (PAR-FL32MA-E / PAR-FA32MA-E) or with other Backlit Simple MA Remote Controllers (PAC-YT53CRAU), with up to two remote controllers per group.

The Backlit Simple MA Remote Controller shall require no addressing. The Backlit Simple MA Remote Controller shall connect using two-wire, stranded, non-polar control wire to TB15 connection terminal on the indoor unit. The Simple MA Remote Controller shall require cross-over wiring for grouping across indoor units.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Operation</th>
<th>Display</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON/OFF</td>
<td>Run and stop operation for a single group</td>
<td>Each Group</td>
<td>Each Group</td>
</tr>
<tr>
<td>Operation Mode</td>
<td>Switches between Cool/Drying/Auto/Fan/Heat/Setback. Operation modes vary depending on the air conditioner unit. Auto and Setback mode are available for the R2/WR2-Series only.</td>
<td>Each Group</td>
<td>Each Group</td>
</tr>
<tr>
<td>Temperature Setting</td>
<td>Sets the temperature from 40°F – 95°F depending on operation mode and indoor unit. Separate COOL and HEAT mode set points available depending on central controller and connected mechanical equipment.</td>
<td>Each Group</td>
<td>Each Group</td>
</tr>
<tr>
<td>Fan Speed Setting</td>
<td>Available fan speed settings depending on indoor unit.</td>
<td>Each Group</td>
<td>Each Group</td>
</tr>
<tr>
<td>Air Flow Direction Setting</td>
<td>Air flow direction settings vary depending on the indoor unit model.</td>
<td>Each Group</td>
<td>Each Group</td>
</tr>
<tr>
<td>Permit / Prohibit Local Operation</td>
<td>Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Reset filter). *1: Centrally Controlled is displayed on the remote controller for prohibited functions.</td>
<td>N/A</td>
<td>Each Group *1</td>
</tr>
<tr>
<td>Display Indoor Unit Intake Temp</td>
<td>Measures and displays the intake temperature of the indoor unit when the indoor unit is operating.</td>
<td>N/A</td>
<td>Each Group</td>
</tr>
<tr>
<td>Display Backlight</td>
<td>Pressing the button lights up a backlight. The light automatically turns off after a certain period of time. (The brightness settings can be selected from Bright, Dark, and Light off.)</td>
<td>N/A</td>
<td>Each Unit</td>
</tr>
<tr>
<td>Error</td>
<td>When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed</td>
<td>N/A</td>
<td>Each Unit</td>
</tr>
<tr>
<td>Test Run</td>
<td>Operates air conditioner units in test run mode. *2 The display for test run mode will be the same as for normal start/stop (does not display &quot;test run&quot;).</td>
<td>Each Group</td>
<td>Each Group *2</td>
</tr>
<tr>
<td>Ventilation Equipment</td>
<td>Up to 16 indoor units can be connected to an interlocked system that has one LOSSNAY unit.</td>
<td>Each Group</td>
<td>N/A</td>
</tr>
<tr>
<td>Set Temperature Range Limit</td>
<td>Set temperature range limit for cooling, heating, or auto mode.</td>
<td>Each Group</td>
<td>Each Group</td>
</tr>
</tbody>
</table>

4.04 Centralized Controller (Web-enabled)

A. AE-200 Centralized Controller
The AE-200A Centralized Controller shall be capable of controlling a maximum of two hundred (200) indoor units across multiple CITY MULTI outdoor units with the use of three (3) AE-50A expansion controllers. The AE-200A Centralized Controller shall be approximately 11-5/32" x 7-55/64" x 2-17/32" in size and shall be powered with an integrated 100-240 VAC power supply. The AE-200A Centralized Controller shall support system configuration, daily/weekly scheduling, monitoring of operation status, night setback settings, free contact interlock configuration and malfunction monitoring. When being used alone without the expansion controllers, the AE-200A Centralized Controller shall have five basic operation controls which can be applied to an individual indoor unit, a collection of indoor units (up to 50 indoor units), or all indoor units (collective batch operation). This basic set of operation controls for the AE-200 Centralized Controller shall include on/off, operation mode selection (cool, heat, auto (R2/WR2-Series only), dry, setback (R2/WR2-Series only) and fan), temperature setting, fan speed setting, and airflow direction setting. Since the AE-200A provides centralized control it shall be able to enable or disable operation of local remote controllers. In terms of scheduling, the AE-200A Centralized Controller shall allow the user to define both daily and weekly schedules (up to 24 scheduled events per day) with operations consisting of ON/OFF, mode selection, temperature setting, air flow (vane) direction, fan speed, and permit/prohibit of remote controllers.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Operation Display</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON/OFF</td>
<td>Run and stop operation.</td>
<td>Each Block, Group or Collective</td>
</tr>
<tr>
<td>Operation Mode</td>
<td>Switches between Cool/Dry/Auto/Fan/Heat. (Group of Lossnay unit: automatic ventilation/vent-heat/interchange/normal ventilation)</td>
<td>Each Block, Group or Collective</td>
</tr>
<tr>
<td></td>
<td>Operation modes vary depending on the air conditioner unit.</td>
<td>Each Group</td>
</tr>
<tr>
<td></td>
<td>Auto mode is available for the R2/WR2-Series only.</td>
<td></td>
</tr>
<tr>
<td>Temperature Setting</td>
<td>Sets the temperature from 57°F – 87°F depending on operation mode and indoor unit.</td>
<td>Each Block, Group or Collective</td>
</tr>
<tr>
<td>Fan Speed Setting</td>
<td>Available fan speed settings depending on indoor unit.</td>
<td>Each Group</td>
</tr>
<tr>
<td>Air Flow Direction Setting</td>
<td>Air flow direction settings vary depending on the indoor unit model.</td>
<td>Each Group</td>
</tr>
<tr>
<td></td>
<td>*1. Louver cannot be set.</td>
<td></td>
</tr>
<tr>
<td>Schedule Operation</td>
<td>Annual/weekly/today schedule can be set for each group of air conditioning units. Optimized start setting is also available.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>*1. The system follows either the current day, annual schedule, or weekly, which are in the descending order of overriding priority.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Twenty-four events can scheduled per day, including ON/OFF, Mode, Temperature Setting, Air Direction, Fan Speed and Operation Prohibition.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Five types of weekly schedule (seasonal) can be set. Settable items depend on the functions that a given air conditioning unit supports.</td>
<td>*2 Each Block, Group or Collective</td>
</tr>
</tbody>
</table>

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Decentralized HVAC Equipment
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<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Operation</th>
<th>Display</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimized Start</td>
<td>Unit starts 5 - 60 minutes before the scheduled time based on the operation data history in order to reach the scheduled temperature at the scheduled time.</td>
<td>Each Block, Group or Collective</td>
<td>Each Block, Group or Collective</td>
</tr>
<tr>
<td>Night Setback Setting</td>
<td>The function helps keep the indoor temperature in the temperature range while the units are stopped and during the time this function is effective.</td>
<td>Each Group</td>
<td>Each Group</td>
</tr>
<tr>
<td>Permit / Prohibit Local Operation</td>
<td>Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Reset filter). *3 Each Block, Group or Collective</td>
<td>Each Block, Group or Collective</td>
<td>*3 Each Group</td>
</tr>
<tr>
<td>Room Temp</td>
<td>Displays the room temperature of the group. Space temperature displayed on the indoor unit icon on the touch screen interface.</td>
<td>N/A</td>
<td>Each Group</td>
</tr>
<tr>
<td>Error</td>
<td>When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed *4 When an error occurs, the LED flashes. The operation monitor screen shows the abnormal unit by flashing it. The error monitor screen shows the abnormal unit address, error code and source of detection. The error log monitor screen shows the time and date, the abnormal unit address, error code and source of detection.</td>
<td>N/A</td>
<td>*4 Each Unit or Collective</td>
</tr>
<tr>
<td>Outdoor Unit Status</td>
<td>Compressor capacity percentage and system pressure (high and low) pressure (excludes S-Series)</td>
<td>Each ODU</td>
<td>Each ODU</td>
</tr>
<tr>
<td>Connected Unit Information</td>
<td>MNET addresses of all connected systems</td>
<td>Each IDU, ODU and BC</td>
<td>Each IDU, ODU and BC</td>
</tr>
<tr>
<td>Ventilation Equipment</td>
<td>This interlocked system settings can be performed by the master system controller. When setting the interlocked system, use the ventilation switch the free plan LOSSNAY settings between “Hi”, “Low” and “Stop”. When setting a group of only free plan LOSSNAY units, you can switch between “Normal ventilation”, “Interchange ventilation” and “Automatic ventilation”.</td>
<td>Each Group</td>
<td>Each Group</td>
</tr>
<tr>
<td>Multiple Language</td>
<td>Other than English, the following language can be chosen. Spanish, French, Japanese, Dutch, Italian, Russian, Chinese, and Portuguese are available.</td>
<td>N/A</td>
<td>Collective</td>
</tr>
</tbody>
</table>

All AE-200A Centralized Controllers shall be equipped with two RJ-45 Ethernet ports to support interconnection with a network PC via a closed/direct Local Area Network (LAN) or to a network.
switch for IP communication to up to three AE-50A expansion controllers for display of up to two hundred (200) indoor units on the main AE-200A interface.

The AE-200A Centralized Controller shall be capable of performing initial settings via the high-resolution, backlit, color touch panel on the controller or via a PC browser using the initial settings.

Standard software functions shall be available so that the building manager can securely log into each AE-200A via the PC’s web browser to support operation monitoring, scheduling, error email, interlocking and online maintenance diagnostics. Additional optional software functions of personal browser for PCs and MACs and Tenant Billing shall be available but are not included. The Tenant Billing function shall require TG-2000 Integrated System software in conjunction with the Centralized Controllers.

B. AE-50A Expansion Controller

The AE-50A Expansion Controller shall serve as a standalone centralized controller or as an expansion module to the AE-200A Centralized Controller for the purpose of adding up to 50 indoor units to either the main touch screen interface of the AE-200A. Up to three (3) AE-50A expansion controllers can be connected to the AE-200A via a local IP network (and their IP addresses assigned on the AE-200A) to the AE-200A to allow for up to two hundred (200) indoor units to be monitored and controlled from the AE-200A interface.

The AE-50A expansion controllers have all of the same capabilities to monitor and control their associated indoor units as the features specified above. Even when connected to the AE-200A and configured to display their units on the main controller, the individual indoor units connected to the AE-50A can still be monitored and controlled from the interface of the AE-50. The last command entered will take precedence, whether at the wall controller, the AE-50A or the AE-200A Centralized Controller.

4.05 The following software functions are optional per AE-200/AE-50/EB-50GU:

1. Personal Web Browser (SW-Pweb): The CMCN shall be capable of allowing up to 50 individual users to monitor and control user defined zones via a network PC or MAC’s web browser.

Tenant Billing (SW-Charge): The CMCN shall be capable of calculating CITY MULTI energy usage in kWh and in a monetary amount based on the energy consumption of the outdoor unit(s) divided among the associated indoor units per AE-200/AE-50/EB-50GU. This software is used in conjunction with the TG-2000 software a networked PC, and Watt Hour Meters (WHM).

HVAC Guide Specifications

Service
Part – 1 Maintenance Tool Software and MN-Converter (CMS-MNG-E)

A. The Maintenance Tool, via the MN-Converter (CMS-MNG-E), shall enable the user to monitor and record the following parameters in a centralized system.

i. Outdoor Unit
   1. Operation Mode (Cooling Only, Heating Only, Cooling Main, Heating Main)
   2. Compressor Frequency, amperages, and voltages
   3. Compressor high- and low-side pressure
   4. System Temperatures
   5. Outdoor temperature
   6. Status of reversing valve

ii. BC Controller
   1. Valve ON/OFF status
2. Temperatures
3. Pressures

iii. Indoor Unit
1. Entering Air Temperature
2. Entering/Leaving Refrigerant Temperature
3. Superheat/Subcool temperatures
4. LEV position
5. Room temperature setpoint
6. Unit Mode and Status (Heat, Cool, Dry, Auto, Fan)

B. The Maintenance Tool shall have the additional feature of controlling the following system components manually:
   i. Indoor Unit
      1. Indoor Unit ON/OFF
      2. Mode (Heat, Cool, Dry, Auto, Fan)
      3. Room Temperature Setpoint
      4. Fan speed
      5. LEV Position
   ii. BC Controller
      1. Valve OPEN/CLOSE
      2. LEV Position

C. The Maintenance Tool shall be connectable to either the TB3 or TB7 communication bus lines on the MNET via alligator connectors.

D. The Maintenance Tool shall be connectable to a PC via a USB cable.

E. Trended data from Maintenance Tool shall be available to export to a data file for offline analysis.

HVAC Design Specifications Professional Services

PART 5 - VRF System Commissioning

5.01 General

A. The VRF Manufacturer shall oversee and assist the installing contractor with the startup and commissioning of VRF equipment as outlined below. This process will be completed in two phases. Phase one shall cover the Pre-Start-Up inspection process, Phase two will cover the Physical Start-Up & Commissioning of Equipment.

B. All VRF System Commissioning activities shall be completed by an employee of the VRF manufacturer whose primary job responsibilities are to provide start up and commissioning of their products; sales staff or in-house support staffs are not permitted to complete this scope of work.

C. A factory certified representative may assist the VRF manufacturer’s personnel in the completion of certain elements of work contained within this specification. Activities completed by a Factory Certified Representative shall be supervised onsite by the VRF manufacturer. Certified representatives shall not be used in lieu of the manufacturer’s personnel.

D. The installing contractor shall have been certified by the manufacturer to install VRF systems, having attended a minimum 3-day VRF Service & Installation course at an approved training center. A copy of this certificate shall be presented as part of the VRF equipment submittal process.
E. The installing contractor shall assist the VRF manufacturer in their completion of the system review and have available a technician with appropriate diagnostic tools, materials and equipment, as required, for the duration of the inspection process. The technician shall be fully licensed and insured to complete necessary duties as directed under the supervision of the VRF manufacturer.

F. Upon completion of the Equipment Start-Up & VRF Commissioning process, the VRF manufacturer shall provide a formal report outlining the status of the system, in electronic format only. Contained within this report shall be copies of all field inspection reports, required action items and status, Manufacturers design software As-Built, equipment model & serial numbers.

G. Completion of the Equipment Start-Up and VRF Commissioning process shall verify that the VRF system has been installed per the Engineer’s design intent and complies with the VRF manufacturers engineering and installation specifications related to their equipment.

H. Compliance with federal, state and local codes as well as other authorities having jurisdictions are not part of this process and are the responsibility of the installing contractor.

I. Contact your regions Mitsubishi Electric Professional Solutions Manager for information and pricing related to services required under this project’s scope of work.

Northeast Business Unit
psgne@hvac.mea.com

South Business Unit
psgs@hvac.mea.com

Southwest Business Unit
psgsw@hvac.mea.com

Central Business Unit
psgc@hvac.mea.com

West Business Unit
psgw@hvac.mea.com

5.02 Pre Start-Up Inspection

A. Contractor shall employ the services of the VRF manufacturer to provide a comprehensive field review of the completed VRF system installation, prior to the physical start up and operation of equipment. Upon satisfaction that the system meets the VRF manufacturer’s installation requirements and specifications, the contractor shall be allowed to proceed with the physical start up and operation of equipment.

B. Prior to the pre-start-up inspection, all systems components shall be in a final state of readiness having been fully installed and awaiting inspection.

C. The installing contractor shall provide the VRF manufacturer a copy of the electronic design file used in the design and engineering process of the system being inspected. This electronic design file shall have been completed on software approved by the specified VRF manufacturer and shall have been updated to reflect as-built conditions.
D. The installing contractor shall have prepared the refrigeration piping systems per equipment installation and service manuals. All refrigerant piping systems, upon completion of assembly, shall have been pressurized to a minimum 600 PSI, using dry nitrogen, and held for an uninterrupted 24HR period, with acceptable change due to atmospheric conditions.

1. A record of the pressure check process shall be recorded and tagged at the outdoor unit. The tag shall contain the following information: date & time of pressure check start, fill pressure, outdoor temperature at start & stop, date & time of pressure check completion, and the person’s full name & company information completing the pressure check.

2. The installing contractor shall engage the General Contractor as a witness of the pressure check process, confirming that all steps and procedures related to the pressure check were properly followed and that the system held the holding pressure of 600PSI for a period of 24hr hours, with acceptable change due to atmospheric conditions. Witness information, including full name, company name, title, phone number and signature shall be recorded on same pressure tag used by installing contractor.

E. Upon completion of the 600 PSI pressure check, the system shall be evacuated to a level of 500 microns, where it will be held for a period of 1HR with no deflection. The installing contractor shall utilize the triple evacuation method per the equipment install and service manuals.

1. Evacuation start & stop dates, times, and persons involved shall be recorded and tagged at the outdoor equipment.

2. Installing contractor shall digitally capture a photo of the micron gauge reading, at the conclusion of the 1hr holding period, for each system and provide a copy to the VRF manufacturer. Each photo shall contain a tag providing the outdoor units Serial number.

F. Upon the completion of the 500-micron hold, the calculated additional refrigerant charge can be added. The calculated refrigerant charge shall have been calculated using the VRF manufacturers design software.

1. Total refrigerant charge of the system shall be recorded and displayed at the outdoor unit by permanent means.

G. A review of the equipment settings shall be completed, with recommendations provided to improve system performance, if applicable. Physical changes of system settings will be completed by the contractor. Electronic recording of final DIP switches shall be provided as part of the commissioning report.

H. A comprehensive review and visual inspection shall be completed for each piece of equipment following a detailed check list, specific to the equipment being reviewed. A copy of the inspection report shall be provided as part of the manufacturers close out documentation. Any deficiencies found during the inspection process shall be brought to the attention of the installing contractor for corrective action. Any system components that are not accessible for proper inspection shall be noted as such.

I. Indoor Equipment report shall contain
   - Model & Serial Number
   - Equipment location
   - Equipment Tag/Identification number
   - Network Address & Port Assignment
   - Digital recording of equipment settings
   - Mounting/support method
   - Seismic restraints used
   - Proper service clearance provided
   - Wiring and connection points are correct
   - High voltage reading(s) within acceptable range
   - Low voltage reading(s) within acceptable range
   - Type of Remote Controller used and its location
   - Occupied space temperature sensing location
   - Air temperature readings within acceptable range
5.03  Physical Start-Up & Commissioning of Equipment

A. Upon proper equipment start up by the contractor, following the manufacturers guidelines and specifications, an employee of the VRF manufacturer shall complete a review of the system performance and complete the following tasks:

B. Check and confirm all communication addressing of system components.

C. Check and confirm each indoor unit, individually, is properly piped and wired by commanding the indoor unit on, in either heat or cool mode and verifying proper response.
   a. This process shall be digitally recorded and included as part of the close out documentation.

D. Electronically record a minimum of one-hour of operational data per refrigeration system.

E. Electronically record selector switch positions on all indoor and outdoor equipment.

F. The VRF manufacturer shall retain the electronically recorded data, collected during the start-up and equipment commissioning process, at a designated location within the US for future reference.

5.04  Close-Out Information

A. The VRF manufacturer shall issue a System Performance report at the completion of all fieldwork. Contained within this report shall be an overview of the system performance, recommendations, field reports, all electronic data, and as-built design file.

5.05  VRF Equipment Warranty

A. Having successfully completed the Pre-Inspection, Start-Up & Equipment Commissioning processes and fulfilling all requirements, as outlined in the VRF manufacturers Extended Warranty Process. Along with installing contractor being certified by the VRFR manufacturer to install VRF systems, having attended a minimum 3- day VRF Service & Installation course at an authorized training center.

B. The equipment shall be provided with the following warranty per the VRF manufacturer’s warranty policy:
   o Compressor: 7-year part only
   o Parts: 5-years part only
   o Labor: no labor coverage provided by VRF Manufacturer
Issued For Construction

Atlanta Airport AC Hotel
216014.00

Decentralized HVAC Equipment
23 81 29.20
SECTION 23 82 00

ELECTRIC HEATERS

PART 1 – GENERAL

1.01 SUMMARY

A. The General Provisions, Supplemental General Provisions, section 23 01 00, Division 1 Specifications and Special Provisions apply to all Work specified in this Section.

B. This section describes the basic materials and installation methods for the electric heaters. Comply with other Division 23 sections and drawings as applicable. Refer to other divisions for coordination of work.

C. Furnish and install all components of the electric heaters specified herein, as indicated on the drawings, and as required to provide complete and operating systems.

1.02 DESCRIPTION OF WORK:

A. Work Included: Provide electric heating and cooling units, as specified, which may include:
   1. Electric wall heaters
   2. Additional information as required in Section 23 01 00.

1.03 QUALITY ASSURANCE:

A. The complete assembly, not just components, shall be approved as a unit by Underwriters' Laboratories, Inc. (UL) and shall bear the UL label, where required by code. Equipment shall be installed and wired in accordance with applicable local and national codes.

1.04 SUBMITTALS:

A. Shop drawings submittals shall include, but are not limited to, the following:
   1. Unit cutsheets clearly showing all features, accessories, dimensions, weights and capacities.
   2. Complete color samples for selection.
   3. Written instructions for equipment to installation.
   4. Wiring and piping diagrams and connection locations.
   5. Performance certifications and test results.
   6. Warranty Information.
   7. Additional information as required in Section 23 01 00.

Part 2 – PRODUCTS

2.01 MANUFACTURERS:

A. Chromalox
B. Indeeco
C. QMark
D. Berko
E. Brasch
F. Markel
G. Electric Heaters, Inc.
H. Nailor
I. Warren

2.02 EQUIPMENT:

A. Electric Wall Heaters:
   1. As manufactured by QMark.
   2. Other acceptable manufacturers: Brasch, Chromalox, Markel
   3. Units shall be UL listed and wired in accordance with NEC.
   4. The heater assembly which fits into the back box shall consist of a fan panel upon which is mounted all of the operational parts of the heater.
   5. The heating element shall be of the non-glowing design consisting of an 80/20 nickel-chromium resistance wire enclosed in a steel sheath to which plate fins are copper brazed. It shall be warranted for 5 years.
   6. Capacities and electrical characteristics: As scheduled on drawings.

Part 3 – EXECUTION

3.01 INSTALLATION:

A. Install units in accordance with manufacturer’s instructions.
B. Install units where indicated on drawings.
C. Provide supports, for pedestal type wall fin per manufacturer’s recommendations.

END OF SECTION 23 82 00
SECTION 26 01 00
GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. The Drawings are schematic and are not intended to show the exact location of outlets, devices, etc. or the routing of conduit.

B. Dimensions and information regarding accurate locations of equipment, and structural limitations and finish shall be coordinated and verified with other Divisions of Work. Be prepared to provide dimensions and information regarding the Work of this Division to other trades.

C. The right is reserved to relocate any device (receptacle, switch, fire alarm, audio/visual, junction box, outlet, etc.) a maximum of 10'-0" before it is permanently provided without incurring additional cost to the Contract.

1.02 REFERENCE STANDARDS

A. All work shall comply with the most recently revised versions of all local, state and federal codes, ordinances of the authority having jurisdiction, laws, rules and regulations. Any modifications required by any of the above shall be made without any additional cost to the owner. Where requirements between governing Codes and Regulations vary, the more restrictive provision shall apply.

B. Nothing contained in the Contract Documents shall be construed as authority or permission to disregard legal requirements and regulations. The Contractor shall thoroughly review the Documents and bring any such conflicts to the attention of the Architect and Engineer prior to installation.

C. All materials shall be new and shall bear the label of U.L.

1.03 DEFINITIONS

A. Provide: to furnish, install and connect.

B. Furnish: to supply all materials, labor, equipment, testing apparatus, controls, tests, accessories and all other items customarily required for the proper and complete application.

C. Install: to join, unite, fasten, link, attach, set-up or connect together, complete, tested, and ready for normal satisfactory operation.

D. Engineer: the Engineer of record.

E. Contract Documents: the complete set of Specifications and Drawings of all Divisions.

F. Work: labor, materials, equipment, accessories, controls and other items required for a complete installation.

G. Concealed: embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces or in enclosures.
H. Conduit: rigid steel; intermediate metal conduit (IMC), plastic conduit (PVC), electrical metallic tubing (EMT), or flexible steel conduit.

I. Manufactured Cable: pre-wired metal clad manufactured cable bearing a U.L. label; metal clad cable (MC), health care (HCF).

J. Wiring/Wired: all wire installed in conduit to equipment, device, junction box, light fixture, etc. from panel board or switchgear with all required boxes, connectors, couplings, etc.

K. Exposed: not installed underground or concealed.

L. Equal: equal in quality, workmanship, materials, weight, size, design and efficiency of the specified product, conforming to manufacturers.

M. Supply: to purchase, procure, acquire and deliver complete with related accessories.

N. Authority Having Jurisdiction (AHJ): applicable local, state and federal authorities having jurisdiction over any part of the Scope within this Division and other Divisions.

1.04 SHOP DRAWINGS AND PRODUCT DATA

A. Refer to SRSS Section 01 33 00.

1.05 AS-BUILT DRAWINGS

A. Refer to SRSSA section 01 78 39 - Project Record Documents.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturer’s names and catalog numbers specified in the Contract Documents are intended to describe the material and set the standard of quality. All bids shall be based on material specified. Request for approval of material not specified shall be considered if the request is in written form and submitted to the Architect no later than fourteen (14) days prior to the bid date. All requests shall conform to the provisions of the general and supplementary conditions.

B. When specific names are not stated, only the best available quality of material or equipment shall be submitted for review and used in the installation.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The equipment selections used in the preparation of the Contract Documents will fit into the physical spaces provided and indicated, allowing ample room for access, servicing, removal and replacement of parts, etc. Adequate space shall be allowed for clearance in accordance with the Code requirements and the requirements of the local Authorities having jurisdiction, and the equipment manufacturer’s recommendations.

B. In the preparation of Drawings, a reasonable effort to accommodate acceptable equipment manufacturer’s space requirements has been made. However, since space requirements and equipment arrangement vary according to each manufacturer, the
C. Physical dimensions and arrangements of equipment to be installed shall be subject to the Architect's and Engineer's review.

D. The General Contractor and all Subcontractors shall coordinate the installation of ductwork, conduit, busway, piping, cable trays, etc., installation with lighting fixtures, special ceiling construction, air distribution equipment, and the structure. Provide additional rises, drops and offsets as required. If after installed, new ductwork, conduit, busway, piping or cable is found to be in conflict with the architecture, structure, or other trade Work which is either existing or shown on the Contract Documents, the ductwork, conduit, busway, piping or cable shall be relocated without additional cost to the Owner.

E. No conduit, equipment, busway, etc., shall be installed in the eight (8) inch high zone directly above the ceiling in tenant areas to allow for tenant build-out and flexibility unless otherwise specifically shown on the Drawings or prior written authorization is received from the Engineer.

F. Accessibility and Clearance:
   1. Electrical equipment, outlets, junction and pull boxes shall be installed in accessible locations, avoiding obstructions, preserving headroom, and keeping openings and passageways clear.
   2. Minor adjustments in the locations of equipment shall be made where necessary, providing such adjustments do not adversely affect functionality of the equipment.

G. Scaffolds and staging for installation of electrical work shall be provided under the work of this Division.

3.02 STRUCTURAL FITTINGS

A. Provide the necessary sleeves, inserts, hangers, anchor bolts, and related structural items. Provide at the proper time.

B. Openings may have been indicated on the Architectural and Structural drawings. Should any additional openings or holes be required, the same shall be provided at no additional cost to the Owner.

C. Location: At a time in advance of the work, verify openings shown on the Architectural and Structural drawings, and coordinate any additional openings.

D. If the work of this Section requires modification of the Architectural or Structural drawings, provide new instructions as to requirements for these openings. Submit for review and coordination to Architect.

E. Sleeves shall be supplied for electrical conduits passing through walls or slabs and shall be placed before concrete is poured.

F. Equipment supports for electrical work shall be fastened to the structure by inserts, anchor bolts, bolting to drilled and tapped structural members, or be welded to the structure.
   1. Welding shall be done by the electric arc method with fully competent welders. Supporting members shall be shop coated with a suitable primer.
   2. Surfaces damaged by installation of supports shall be touched up with primer to match shop coat. Any drilling of structural members shall be approved by the Architect.

G. Flashing:
1. Wherever conduits pass through the roof or outer walls, base flashing and counter
flashing shall be provided.
2. Such flashing shall be properly installed by skilled workmen, and shall include
grouting, mastic or tar application, or other means to insure a permanent, waterproof,
neat and workmanlike installation.
3. Insofar as possible, flashing shall comply with and be similar to requirements for
flashing in General Construction Work.

H. Anchor bolts and inserts shall be galvanized and of adequate size and strength for
installation of electrical work and shall be placed in forms before concrete is poured.
1. Placement of bolts in bases shall be done under other Division. Provide detail
drawings, templates, and anchor bolts for bases to the General Contractor in time to
avoid delaying work schedules.
2. Expansion shields shall only be used with specific approval of the Architect. Wooden
or soft metal plugs shall not be used.

I. Cutting and patching:
1. All additional cutting, patching and reinforcement of construction of building, subject
to review by the Architect, shall be performed under this Section.
2. Refer to appropriate Division for requirements.

3.03 WEATHERPROOF EQUIPMENT
A. Electrical devices or equipment located in damp, semi-exposed areas shall be weather-
resistant. Enclosures shall comply with NEMA Type 3R requirements.

B. Surface mounted outlet boxes shall be cast metal with threaded bolts. Pull or junction
boxes shall be cast metal with bolted and gasketed covers.

C. Outlet box covers shall be of a suitable weatherproof type with gaskets, packing glands,
weatherproof doors, or other required means to prevent entry of moisture.

D. Lighting fixtures shall be provided with suitable gasket, and UL labeled for location.

3.04 CLEANING
A. Brush and clean work prior to concealing, painting and acceptance. Perform in stages if
directed.

B. Painted exposed work soiled or damaged: Clean and repair to match adjoining work
before final acceptance.

C. Remove dust and debris from inside and outside of material and equipment.

3.05 IDENTIFICATION OF CIRCUITS AND EQUIPMENT
A. Numbered adhesive strip tags shall be attached to branch circuit wiring in conduits at
every point where runs are broken or terminated. Also tag pull wires in empty conduits.

B. Junction and Pull boxes shall have covers stenciled with box number when shown on the
drawings, or circuit numbers according to panel schedules. Data shall be lettered in a
conspicuous manner with a color contrasting to finish.

3.06 TESTS AND DEMONSTRATIONS
A. All systems shall be tested in the presence of the Owner or an Owner designated
representative upon completion of the Work and demonstrates that the installation is in
accordance with the Contract Documents.
B. All motors shall be checked and adjusted for correct direction of rotation.

C. Loading of circuits and feeders in panelboards shall be checked and balanced.

D. Any work found not to be in compliance with the Contract documents shall be repaired or replaced without incurring additional cost to the Contract price.

E. Provide all instruction to the Owner on maintenance and operation of all systems and equipment provided under this Division.

3.07 WARRANTIES

A. The warranty period for all systems, equipment, components, work, etc. shall be no less than one (1) year, unless specified otherwise hereinafter and shall include at least one (1) full heating season and one (1) full cooling season.

B. The Contractor shall, without cost to the Owner, remedy any defects within a reasonable time to be specified in notice from the Architect. In default thereof, the Owner may have such work done and charge all costs to the Contractor.

C. The start of the Contractor’s warranty period, as defined in the General Conditions, shall commence on the issue of a “Certificate of Substantial Completion”, by the Owner or the Owner’s Representative for each item of material, equipment or system.

D. The Subcontractor shall confer with the General Contractor prior to the bid date concerning the project schedule and determine if there is a need to operate any items of equipment or systems for temporary heating an/or cooling or other reasons prior to “Substantial Completion”. All required extended warranty costs for equipment, materials, and systems shall be included in the Subcontractor’s bid.

END OF SECTION 26 01 00
SECTION 26 05 00
RACEWAYS AND WIRING – 600 VOLT

PART 1 - GENERAL

1.01 SUMMARY

A. Provide all raceways and wiring specified herein and as required to provide a complete system throughout the project as indicated on the Drawings.

PART 2 - PRODUCTS

2.01 CONDUIT

A. Galvanized Rigid Steel Conduit (GRC): Rigid steel conduit shall be galvanized, constructed of high-grade raw steel piping, galvanized inside and outside with threaded joints.

B. Intermediate Metal Conduit (IMC): IMC shall be constructed of high-grade steel tubing, galvanized inside and outside with threaded joints. Zinc coating shall be applied by the hot-dip, galvanized process.

C. Electrical Metallic Tubing (EMT): EMT shall be constructed of high-grade steel, zinc coated and galvanized inside and outside.

D. Rigid Plastic Conduit (PVC): PVC conduit shall be polyvinyl chloride rigid scheduled to heavy wall type. PVC conduit shall be joined with PVC couplings of the solvent cement type to provide complete watertight joints. Conduit systems shall be UL listed for direct burial and exposed use.

E. Flexible Metal Conduit: Shall be flexible steel conduit tubing spirally wound having a hot-dip galvanized coating and meeting requirements of UL for flexible metal conduit.

F. Liquid tight Flexible Metal Conduit: Shall be flexible steel conduit spirally wound and shall have a copper grounding strand and factory-applied neoprene jacket. Liquid tight flexible conduit shall meet the requirements of UL.

2.02 CONDUIT FITTINGS

A. GRC and IMC: shall be factory-made taper threaded and of the same material as the conduit. Provide with molded nylon insulating bushing or throat at all boxes and cabinets with locknuts inside and outside. Provide watertight hubs in wet locations for terminations into enclosures. Provide insulated grounding bushing where required.

B. EMT: shall be of the same material as the conduit and shall be hexnut compression or steel setscrew. Provide with molded nylon insulating bushing or throat at all boxes and cabinets. Provided insulated grounding bushing where required.

C. PVC: shall be Schedule 40 and of the same manufacturer as the conduit.

D. Flexible Metal Conduit and Liquidtight Flexible Metal Conduit: Provide couplings at connections between flexible and rigid conduit suitable for that application. Provide with nylon-insulated busing or throat at all boxes and cabinets with locknuts.
E. Expansion Joints: Provide O.Z./Gedney, Type AX expansion joint fittings for all conduit which crosses an expansion joint. Provide with internal ground and external bonding jumper.

F. Wire Support Bushings: Provide for vertical runs as required by the NEC.

2.03 PRE-WIRED MANUFACTURED CABLE

A. Pre-wired manufactured cable may be used for branch circuit wiring for receptacle and lighting circuits where acceptable by the AHJ.

B. Pre-wired manufactured cables shall NOT be used for:
   1. Mechanical equipment branch circuits
   2. Feeders
   3. Homeruns
   4. Exposed

C. Conduits connecting receptacle and switch circuits to lighting and power homerun boxes in finished areas, type “MC” cable consisting of one (1), two (2), three (3) or four (4) copper “THW”, “THHN” or “THHN/THWN” insulated phase, neutral and ground conductors. Ground shall be of minimum size required by NEC, as specified in other Sections and as noted on the Drawings.

D. Pre-wired cables used for receptacle and equipment through-out a “health-care facility” shall be type “HCF”, with a continuous green colored metal sheath UL approved for grounding purposes.

E. Pre-wired manufactured cable may be used where concealed in walls or in millwork only. Cable shall run from the first device in the wall or millwork or first light fixture to a structurally mounted junction box no more than 10’-0” from the point which the cable enters the ceiling space or from first light fixture.

F. Cable shall not pass through a fire rated wall or assembly.

G. Acceptable cable manufactures are AFC, Alflex and Southwire.

H. Cable termination fittings shall be O. Z. Gedney C5, T&B #253, Steel City Series XC-400 or approved equal clamp-type, malleable iron fittings. Die-cast fittings are not acceptable.

2.04 JUNCTION BOXES AND PULL BOXES

A. Junction boxes and Pull boxes shall be galvanized steel with mode size and gauge as required by the NEC in accordance with voltage parameters. Covers shall be of the same gauge as the box as shall be screw fastened. Boxes shall be sized as required but no smaller than 4 inches square and 1-1/2 inches deep.

B. Covers shall be accessible.

C. Provide galvanized cast iron or aluminum with threaded hubs and gaskets for outdoor and damp locations.

D. Boxes in grade or underwater shall be cast brass or bronze.

2.05 OUTLET BOXES

A. Outlet boxes shall be UL listed, and of sizes and types required for the application.
B. Boxes Recessed in Construction: Sheet steel boxes, unless noted or required otherwise. Boxes shall be no lighter than 14 gauge and shall be galvanized after fabrication. Set so face of box will finish flush with building surface.
   1. For Lighting Fixture Outlets: 4-inch square with raised fixture ring.
   2. For Wall Switches, Receptacles, and Communication Use: 4 inch square, one-piece; no sectional boxes permitted. Use boxes with plaster rings in all plastered walls where wall thickness permits. Use boxes less than 1-1/2 inch deep only in locations where deep boxes cannot be accommodated by construction.
   
C. Boxes Used Outdoors or in Damp/Wet Locations: Cast metal boxes (iron and alloy) with gasketed covers and threaded hubs.

D. Boxes in Hazardous Areas: Approved cast metal boxes with appropriate sealing fittings.

E. Provide blank cover for boxes without fixture or device.

F. Boxes in grade or underwater shall be cast brass or bronze.

G. Cycolac: Per code for pools and fountains only.

2.06 WIREWAYS AND AUXILLARY GUTTERS

A. Wireways shall be constructed in accordance with UL 870. Every component including lengths, connectors, and fittings shall be UL listed and labeled. Provision shall be included in the construction to allow screwed the hinged cover closed without the use of parts other than the standard lengths, fittings, and connectors. It shall also be possible to seal the cover in the closed position with a sealing wire.

B. Wireways shall be constructed with/without knockouts, as required. Enclosure type shall be as required by conditions encountered.

C. Gutters and Wireways shall be suitable for "lay-in" conductors. Connector covers shall be permanently attached so that removal is not necessary to utilize the lay-in feature.

D. All sheet metal parts shall be provided with a rust-inhibiting phosphatizing coating and gray baked enamel finish. All hardware shall be plated to prevent corrosion. All screws installed toward the inside shall be protected by spring nuts or otherwise guarded to prevent wire insulation damage.

E. All connectors shall be slip-in type with self-retaining mounting screws. All hangers shall be two-piece with hook-together feature to permit pre-assembly of wireway and hanger bottom plate before hanging on pre-installed upper bracket.

2.07 SURFACE METAL RACEWAY

A. Surface metal raceway shall be UL listed and labeled; shall be used together with couplings, clips, bushings, straps, connectors, connection covers, elbows, extension boxes, fixture boxes, extension adapters, blank covers and all other required fittings; shall be of the proper size to accommodate the conductors to be installed therein in each case.

2.08 CONDUCTORS – 600 VOLTS OR LESS

A. Provide conductors of stranded copper, 98% conductivity, new building wire, insulated in accordance with the requirements of the NEC. Insulation shall be rated no less than 600-volt. Conductors shall be Type "THWN" or "THHN/THWN". Conductors for service and distribution feeders shall be "XHHW". Solid conductors terminating in a breaker or device shall be utilized for wire size No. 12. Sizes specified are AWG gauge for
No. 4/0 and smaller and circular mils (kcmil) for sizes larger than No. 4/0. Minimum wire size shall be No. 12.

B. Connectors: Make splices and connections in conductors using UL connectors.
   1. Stranded Conductors: UL listed, solderless, bolted pressure or compression connectors. Connectors shall be of proper sizes to match conductor sizes.
   2. Solid Conductors: UL listed, bolted pressure or spring connectors. Connectors shall be of proper sizes to match conductor sizes.
   3. Motor Lead Pigtails: UL listed, crimp lugs with through-bolt fasteners between lugs. Lugs shall be of proper sizes to match conductors. Proper sized dies and tools shall be provided to apply connectors.
   4. Lighting Fixture Taps: Electrical spring connectors as specified for solid conductors.
   5. Ground connections: Burndy ground clamps or connectors of a type suitable for and having a UL listing for grounding applications.

C. All conductor sizes shown on the Drawings are copper unless specifically noted otherwise. All ground conductors shall be copper.

2.09 MANUFACTURERS

A. Conduit (GRC, IMC, EMT)
   1. Allied
   2. Republic
   3. Triangle
   4. Wheatland

B. Conduit Fittings (GRC, IMC, EMT)
   1. Appleton
   2. O.Z. Gedney
   3. Steel City
   4. Thomas and Betts
   5. Raco

C. Flexible Metal Conduit
   1. AFC
   2. Alflex
   3. Anaconda
   4. International Metal Hose

D. Liquidtight Flexible Metal Conduit
   1. American Brass Company
   2. Anaconda
   3. Electri-Flex Company

E. PVC Conduit and Fittings
   1. Thomas & Betts
   2. Prime Conduit
   3. Cantex
   4. Certainteed
   5. Triangle

F. Conductors, Copper, 600 Volts or less
   1. American Insulated Wire
   2. Cablec
   3. General Cable
   4. Pirelli
   5. Southwire
   6. Triangle
PART 3 - EXECUTION

3.01 CONDUIT

A. PVC (encased in 4” concrete on all sides) or Galvanized Rigid Steel (GRC) meeting corrosion resistant protection of NEC 300.6 shall be used for underground service entrance and underground feeders. When PVC is used, a transition to metal conduit shall be made below grade using GRC 90 degree fitting such that only metal conduit exits concrete or ground.

B. GRC or Intermediate Metal Conduit (IMC) shall be used where exposed and subject to physical damage, or installed in damp or wet locations.

C. PVC shall be used for underground branch circuits, underground feeders where run below the slab on grade, 1” maximum in the slab on grade, 1” maximum in the slabs above grade, in concrete columns and concrete wall and in masonry walls.

D. PVC Schedule 80 (or GRC meeting corrosion resistant protection of NEC 300.6) may be used for direct burial for branch circuits only. When PVC is used, a transition to metal conduit shall be made below grade using GRC 90 degree fitting such that only metal conduit exits concrete or ground.

E. Electrical Metallic Tubing (EMT) shall be used for branch circuits concealed in walls and ceilings. EMT may be used for feeders where not exposed to damage and/or not installed in wet or damp locations.

F. Flexible Metal Conduit shall be used for connections to rotating or vibrating equipment. The lengths shall be as short as possible, in no case longer than 6’ or shorter than 12”.

G. Liquidtight Flexible Metal Conduit shall be used for connections to rotating or vibrating equipment where located outdoors or in damp or wet locations. The lengths shall be as short as possible but in no case longer than 6’ or shorter than 12”. Liquidtight Flexible Metal Conduit shall NOT be located above a ceiling, in an air shaft or in a mechanical room utilized as a return air plenum.

H. Raceways shall be installed as a complete and total wiring enclosure system from outlet to outlet, to junction box, pull box, panel or cabinet prior to the installation of the conductors.

I. All conduit shall be run concealed (except in electrical, mechanical and similar area) unless shown otherwise. Where conduit is run exposed it shall be run in a neat and orderly manner. All conduit shall be run parallel and perpendicular to the building structure.
J. Conduits shall be secured to all boxes, cabinets, panels and equipment with locknuts and bushings and shall be securely fastened in place on intervals required by the Code and local codes; hangers, supports or fastenings shall be provided at each elbow and at the end of each straight run within 3’ of a termination to a box or cabinet. All supports shall be independent and shall not use ceiling supporting system wires.

K. Use threaded rods and hangers for supporting single conduit. Multiple conduits shall be supported using a trapeze of Unistrut (or Kindorf) channels and threaded rods with double nut/washer.

L. Provide pullboxes as shown and/or as required by Code and where necessary in the raceway system to avoid excessive runs or too many bends. Boxes shall have removable hinged or screw covers and shall be accessible.

M. The minimum size conduit shall be ½” diameter. Homeruns shall extend from the first outlet or device to the panel designated and shall be a minimum ¾” diameter.

N. Provide non-hardening elastic type duct seal compound for each conduit entering the building from the outside and from one space to another having a normal operating temperature differential greater or less than 10 degrees F.

O. Provide seals around all conduit and sleeves penetrating through walls, partition or ceilings. Provide UL approved fire resistant seal around all penetrations through fire rated barriers to maintain the barrier rating.

P. Provide pull wire or nylon rope in all empty conduits.

3.02 CONDUIT PROTECTION

A. Provide underground conduit with a top cover at least 30" below finished grade and no more than 48”.

B. Mark all duct bank runs with a detectible warning tape specifically formulated for prolonged use underground, resistant to alkalis and acids found in soil, installed no less than 8 inches and no more than 12 inches above the top of the duct bank concrete. Place warning tape along the approximate center line of the duct bank run. Warning tape shall be permanent, red in color, continuous printed, aluminum backed tape, compounded for direct burial not less than 3 inches wide and 4 mils thick. Printed legend shall be indicative of general type of underground line below.

C. Mark all underground conduit runs with a detectible warning tape specifically formulated for prolonged use underground, resistant to alkalis and acids found in soil, installed no less than 6 inches and no more than 10 inches above the top of the conduit. Place warning tape along the approximate center line of the conduit run. Warning tape shall be permanent, red in color, continuous printed, aluminum backed tape, compounded for direct burial not less than 3 inches wide and 4 mils thick. Printed legend shall be indicative of general type of underground line below.

D. Future

3.03 CONDUCTORS – 600 VOLTS OR LESS

A. No conductor shall be smaller than No. 12 except for signal or control circuits.

B. All conductors shall be installed in conduit.

C. Where a connection is made to any terminal of 40 amperes or more and/or conductors No. 8 or larger, copper terminal lugs shall be bolted to the conductors. Where multiple
terminal lugs are made, individual lugs for each conductor shall be used. Where aluminum conductors are accepted in this Section or noted on the drawings, the terminations shall be made with high compression lugs as manufactured by Ideal or MAC.

D. A maximum of six (6) current carrying conductors shall be run in a conduit. The neutral shall be considered a current carrying conductor.

E. For homeruns of 120 Volt, 20 amp circuits, where the length of run from the panelboard to the center of the load exceeds 100'-0" the conductors shall be No. 10 minimum. If that length exceeds 200'-0" the conductors shall be No. 8 minimum.

F. For homeruns of 277 Volt, 20 amp circuits where the length of run from the panelboard to the center of the load exceeds 200'-0" the conductors shall be No. 10 minimum.

G. Multiple branch circuits homeruns serving computer loads, electronic lighting ballasts and/or H.I.D. lighting ballasts shall utilize a neutral conductor one trade size larger than the phase conductors or use separate neutrals for each circuit. Neutral conductors for individual branch circuits may be the same size as the phase conductor but not less.

H. Provide an equipment grounding conductor in all feeder and branch circuit conduits. Size per code unless shown otherwise.

I. Conductors shall have color coded jackets the entire length for sizes No. 6 and smaller. The conductors for sizes No. 4 and larger shall have color coded marking tape or color coded jackets the entire length. Colors shall be as follows:

120/208 Volt System
Phase A – Black
Phase B – Red
Phase C – Blue
Neutral – White
Ground – Green

[OR]

120/208 Volt System
Phase A – Black
Phase B – Red
Phase C – Blue
Feeder or Shared
Neutral – White
Branch Phase A Neutral
– White w/ Black
Stripe
Branch Phase B Neutral
– White w/ Red
Stripe
Branch Phase C Neutral
– White w/ Blue
Stripe
Ground - Green

J. Where phase marking tape is used it shall be wrapped 2" wide and located at two (2) locations 6" and 18" from the termination. Phase marking tape for the neutral and grounding conductors shall be provided where visible at any point where the conductor is accessible.
J. Before pulling any wire into conduit, thoroughly swab the conduit and clean the boxes of debris.

K. Run feeders in continuous lengths, without joints or splices. Joints shall occur in branch circuits only in locations where they divide.

L. Run conductors for emergency power in conduits separate from all other wiring.

M. Bundle conductors in switchboards and panelboard cabinets and similar using nylon straps made for the purpose. Conductors No. 8 and larger shall be bundled in individual circuits.

3.04 JUNCTION BOXES, PULL BOXES, AND OUTLET BOXES

A. All junction boxes and pullboxes shall be sized in accordance with the Code.

B. All boxes shall be rigidly secured in position to building structure. Boxes larger than 4” shall be secured at two points.

C. Outlet boxes shall be flush with the finished wall or ceiling, or not more than ¼” back, unless specifically shown as surface mounted or its purpose is to be above the ceiling.

D. Provide galvanized steel or cast type outlet boxes. Where exposed GRC or IMC terminates in a box, provide cast box with threaded hubs.

E. All boxes shall be provided with a cover plate.

F. All outlet boxes shall be mounted vertically unless noted otherwise.

G. Where outlets are shown at the same location but at different heights, they shall be mounted one above the other along the same centerline.

H. The exact mounting height of an outlet may be adjusted slightly to align with masonry joint where approved by the Architect.

I. Verify outlet locations in finished spaces with Drawings of interior details and finishes.

J. Outlets shall NOT be located back to back. Where outlets are shown on opposite sides of a wall, they shall be located in separate stud spaces.

K. Protect floor boxes from entering debris during construction using temporary covers approved by the floor box manufacturer.

L. Provide barriers in outlet boxes for switches separating different phases for voltages exceeding 150 volts to ground.

M. Boxes shall not be supported from a suspended ceiling.

END OF SECTION 26 05 00
PART 1 - GENERAL

1.01 SUMMARY

A. Provide all equipment, materials, tools, and labor to provide a complete grounding system.

B. Ground all metallic parts of the electrical system which are not intended to carry current such as conduit, busduct, switchgear, panelboards, cabinets and enclosures, motor frames, device boxes, etc., in accordance with the NEC and applicable codes.

C. In non-metallic conduits, maintain continuity of equipment grounding by installing an insulated grounding conductor and connected by an acceptable method.

PART 2 - PRODUCTS

2.01 GENERAL

A. All equipment and materials provided under this Section of the Specifications shall be new, UL listed, and bear the UL label.

B. All switchboards, panelboards, motor control centers, transformers, busway, etc. shall be provided with a copper equipment ground bar bolted, brazed, or riveted to the associated enclosure or cabinet. All receptacles, switches, disconnects, individual motor controllers, etc. shall be provided with a grounding terminal connected to the device frame or enclosure.

C. All conduit, cable tray, manufactured wiring systems, raceways, junction boxes, pull boxes, etc. shall be made electrically continuous by means of grounding conductors, bonding jumpers, grounding bushings, etc. as required by the NEC and the authorities having jurisdiction.

D. Refer to other Sections for additional grounding requirements.

2.02 GROUNDING CONDUCTORS

A. All grounding electrode conductors shall be bare or green insulated copper conductors sized per the NEC, unless noted on the Drawings. Where the authorities having jurisdiction or local code requires grounding electrode conductor sizing in excess of that shown on the Drawings or specified herein, the larger size conductor shall be installed.

B. All equipment grounding conductors shall be green insulated copper conductors sized as indicated on the Drawings. Where the authorities having jurisdiction or local code requires equipment grounding conductor sizing in excess of that shown on the Drawings or specified herein, the larger size conductor shall be installed.

C. All bonding conductors shall be flexible copper bonding jumpers sized in accordance with the NEC for grounding electrode conductors.
2.03 GROUND RODS

A. All ground rods shall be a minimum of ¾” x 10'-0” copper clad steel unless otherwise indicated on the Drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Provide adequate and permanent service neutral and equipment grounding in accordance with the NEC and as follows.

B. Each system of electrically continuous metallic piping and ductwork shall be electrically grounded in accordance with the requirements of the NEC for "bonding" as they apply to the "bonding of piping systems". Isolated metallic piping and duct systems shall be bonded to the building equipment grounding system.

C. Bonding and grounding conductors shall be sized, shall be run in conduit, and shall be connected to various services in accordance with the requirements of the authorities having jurisdiction and the NEC.

D. Grounding Electrode System

1. Provide a made electrode encircling the structure consisting of a No. 3/0 bare stranded copper conductor buried in direct contact with the earth 30” below finished grade and a minimum of 36” clear of the foundation (ground ring). The loop formed shall be bonded at each building perimeter column to the metal frame of the building and the concrete encased steel reinforcing bars in building floorings. Provide a ground rod at each column line bonded to the ground ring with a No. 3/0 bare stranded conductor. The ground rod shall be installed a minimum of 12” below finished grade.

2. Extend from the made electrode a No. 3/0 insulated stranded copper conductor in a 1 1/4” conduit to a single point ground bar (Erico EGBA144**GG Length as required) at each main service disconnect and connect to the main disconnect neutral bar, housing and frame using No. 3/0 stranded conductor.

3. Provide a building grounding riser as follows:
   a. Provide a single point ground bar in the main electrical room connected to the made electrode and each service main disconnect with a No. 3/0 insulated stranded copper conductor in a 1” conduit.
   b. Provide a ground bar (Erico EGBA14412GG) in each branch electrical room connected to the ground bar in the main electrical room with a 250kcmil insulated stranded copper conductor in a 1 ½” conduit.
   c. Provide a ground bar (Erico TGBA 16L08PT) in each communications room (and other rooms as noted on the Drawings) connected back to the closest electrical room ground bar on the same floor with a #2 insulated stranded copper conductor in a 1” conduit.

5. The following electrodes shall be bonded together with a No. 3/0 insulated stranded copper conductor in 1” conduit to form a grounding electrode system:
   a. Made electrode described above.
   b. Underground main metallic water pipe. Connect ahead of the first valve and provide a bonding jumper across the water meter.
   c. Structured steel building frame.
   d. Where the above electrodes are not available or feasible, provide suitable grounding electrodes per NEC.
6. Where nonmetallic insulating coupling, dielectric flanges or similar are used in metallic water piping, provide a No. 3/0 insulated stranded copper conductor across the couplings with the conductor attached to the water line with clamps on each side of the coupling.

7. Provide exothermic type chemical welded type connectors (Cadweld or approved equal) for the joining of conductors to ground rods, grounding plates and splicing. Provide compression and bolted type connectors for the joining of grounding electrode conductors to the ground bars.

8. Provide a separate green-insulated equipment grounding conductor, with insulation of the same rating as the phase conductors, for all feeders and branch circuits. Install the grounding conductors in the raceway with related phase and neutral conductors. Where parallel conductors in separate raceways occur, provide a grounding conductor in each raceway. Connect all grounding conductors to ground terminals at each end of the run so that there will be no uninterrupted grounding circuit from the point of ground fault back to a point of connection of the equipment ground and system neutral.

9. Connect the secondary neutral point and the enclosure in each dry type transformer together and run a grounding electrode conductor from their common point of connection to the building grounding electrode system.

10. Provide grounding bushings on all raceways terminating within all electrical enclosures. Provide grounding conductors from such bushings to the frame of the enclosure, ground bus and equipment grounding strap where one occurs.

11. Connect the unit substation neutrals where applicable and equipment ground to a common point within the metallic enclosure containing the main service disconnecting means. Equipment grounds and the identified neutral of the wiring system shall not be interconnected beyond this point in the interior wiring system.

12. Assure the electrical continuity of all metallic raceway systems, pulling up all conduits and/or locknuts wrench-tight. Where expansion joints or telescoping joints occur, provide bonding jumpers. Wherever flexible metallic conduit is employed, provide a green insulated ground jumper installed in the flexible conduit.

13. Provide an insulated green bonding jumper from the grounding screw in the outlet box. Do not install behind the device mounting screws.

14. Provide a No. 6 copper ground to the telephone company main distribution frame and to each telephone backboard.

3.02 TESTS

A. Provide ground continuity tests at all switchboards, transformers, panel boards, distribution panels, motor control centers, main disconnects and transfer switch equipment.

B. After completion of the grounding system measure the system ground resistance. If the resistance to ground exceeds 5 ohms, additional ground rods, or other method approved by the Engineer, shall be provided until a reading of 5 ohms or less is achieved.

C. Perform tests in dry weather and not less than 48 hours after rainfall.

D. Test instruments: Null balance type, Biddle Meggar Earth Tester or approved equal.

E. Provide a report with all resistance readings, calculations and performed corrections and submit two (2) copies to the Architect.

END OF SECTION 26 05 26
PART 1 - GENERAL

1.01 SUMMARY

A. Provide all equipment, materials, tools and labor to properly identify electrical equipment and related accessories.

B. Provide identification for the following:
   1. Switchgear, switchboards, distribution panels, panelboards, disconnect switches, circuit breakers, motor starters, motor control switches, start/stop buttons, EPO switches, and other electrical equipment.
   2. Junction boxes and pullboxes.
   3. Wiring devices.
   4. Wiretags for wiring.
   5. Raceways.

C. Related Section
   1. 26 24 00 – Service and Distribution.
   2. 26 27 00 – Devices.
   3. 26 29 00 – Motor Controls and Wiring.

PART 2 - PRODUCTS

2.01 IDENTIFICATION

A. Nameplates
   1. Nameplates shall have the surface color and core color for engraved letters as follows:
      a. Normal distribution
         1) 120/208V. equipment – black surface with white core
      b. Emergency distribution
         1) 120/208V. equipment – red surface with white core
   2. Provide a nameplate for each switchgear, switchboard, panelboard, distribution panel, motor starter, disconnect switches, motor control center and similar distribution equipment clearly identifying the equipments' name to match that indicated in the Drawings.
   3. Provide a nameplate for each feeder protective device in each switchgear, switchboard, distribution panel, motor control center and any other similar equipment. Identify the specific load it serves.
   4. Nameplates shall be bakelite, 1/16” thick minimum with 3/8” high letters.

B. Junction Boxes and Pullboxes
   1. Provide identification with permanent ink marking pen on the cover of junction boxes noting the branch circuits and systems within the conduit.
   2. Pullboxes shall be marked using stenciled paint noting the voltage and systems served. Letters shall be appropriate height so that they can be read from the floor.
3. Boxes containing Emergency systems: write the abbreviation “EMER” above the circuit number on junction box covers. Write “EMERGENCY” in stenciled “RED” paint on pullboxes above other markings.

C. Disconnect switches and motor starters
   1. Provide nameplates as described above for all disconnect switches and motor starters located 8'-0” above finished floor or less. Identify equipment served.
   2. Provide identification with permanent ink marking pen on all disconnect switches and motor starters mounted over 8'-0” above finished floor. Write marking clearly and in a location that can be read from the floor when the area is finished (e.g. marking for disconnects serving mechanical equipment that will be above the ceiling when the area is finished shall be located on the bottom or bottom front of the disconnect so it can be read when a ceiling tile is removed).

D. Wiring device wall plates
   1. For critical care outlets in health care facilities provide identification on the face of the coverplate with red printed lettering on a white adhesive background as to the panel and circuit the outlet is served. Characters shall be ¼” high.

E. Push button switches
   1. Provide nameplates as described above for all push button switches. Letters shall be ¼” high.

F. Emergency power off buttons (EPO)
   1. Provide nameplates as described above for EPO switches. Nameplate shall have a red surface and a white core. The letter shall be ½” high reading “EMERGENCY POWER OFF”.

G. Wire markers
   1. Wire markers for identification of wiring shall be self-adhesive type having letters and numerals indicating feeder or branch circuit number. Locate markings on wiring where visible near the terminations and taps in all junction boxes, outlet boxes, panelboards, distribution panel boards, switchboards and motor control centers.

H. Electrical services
   1. Where multiple electrical services are provided to a building, provide nameplates as described above identifying the appropriate service number. Letters shall be 1” high.
   2. Where the multiple electrical services are in different locations, provide a nameplate at each service noting the locations of the other service(s) as required by the NEC and the AHJ.

PART 3 - EXECUTION

A. Nameplates shall be applied to a cleaned surface and shall be plumb and level.

END OF SECTION 26 05 50
SECTION 26 09 36
LIGHTING CONTROLS

PART 1 - GENERAL

LIGHTING CONTROLS

1.1 SUMMARY

A. Section Includes: Standalone lighting control systems and associated components.
1. Fluorescent electronic dimming ballasts.
2. LED drivers.
3. Power interfaces.
4. Main units (Lutron Grafik Eye QS).
5. Lighting control panels (Lutron Custom Combination Dimming Panel).
6. Control stations.
7. Low-voltage control interfaces.
8. Wired sensors.

B. Related Sections:
1. Section 26 50 10 – Light Fixtures

1.2 REFERENCE STANDARDS


B. ANSI/ESD S20.20 - Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices); 2007.

C. IEC 60929 - AC and/or DC-Supplied Electronic Control Gear for Tubular Fluorescent Lamps - Performance Requirements; 2011.


H. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits; 2002 (Cor 1, 2012).


J. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the placement of sensors and wall controls with millwork, furniture, equipment, etc. installed under other sections or by others.
   2. Coordinate the placement of wall controls with actual installed door swings.
   3. Where motorized window treatments are to be controlled by the lighting control system provided under this section, coordinate the work with other trades to provide compatible products.
   4. Coordinate the work to provide luminaires and lamps compatible with the lighting controls to be installed.
   5. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

B. Pre-installation Meeting: Conduct on-site meeting with lighting control system manufacturer prior to commencing work as part of manufacturer's standard startup services. Manufacturer to review with installer:
   1. Low voltage wiring requirements.
   2. Separation of power and low voltage/data wiring.
   3. Wire labeling.
   4. Control locations.
   5. Load circuit wiring.
   6. Connections to other equipment.
   7. Installer responsibilities.

C. Sequencing:
   1. Do not install sensors and wall controls until final surface finishes and painting are complete.

1.4 SYSTEM DESCRIPTION
A. The control system is intended and designed to be a fully integrated dimming system that uses current technology to provide lighting control and maximize energy savings in specified rooms. The system shall communicate with a building management control. The intent is to provide a single dimming rack or racks at logical locations within the building infrastructure that allows for overall monitoring and configuration from a single point of control (Engineering) or locally at each respective room.

B. Room Configurations
   1. Lobby: 4 -Scene preset control panel to be located in the back-of-house corridor adjacent to the reception desk and (1) 4 -Scene preset control panel to be located at the reception desk. The lighting in the lobby will consist of low voltage halogen, LED retrofit, linear LED sources and/or RGBW Color Changing LED. The control system will need to be able to control all these sources and any interface or other devices required to control the lighting will be need provided as part of the base contract.
   2. Lounge: 4 -Scene preset control panel to be located at the bar. The lighting in the lobby will consist of low voltage halogen, LED retrofit, linear LED sources and/or RGBW Color Changing LED. The control system will need to be able to control all these sources and any interface or other devices required to control the lighting will be need provided as part of the base contract. There will be color changing DMX control station behind bar.
   3. Breakfast Area: 4 scene preset control panel to be located adjacent to the buffet station. The lighting in the lobby will consist of low voltage halogen, LED retrofit, linear LED sources and/or RGBW Color Changing LED. The control system will need to be able to control all these sources and any interface or other devices required to control the lighting will be need provided as part of the base contract.
   4. Meeting Room: - 4 scene preset control panel to be located at the entry. The lighting in the rooms will consist of LED Integrated Lamps and Recessed LED Troffer type fixtures with gray scale control via nLight digital lighting control system. The control system will need to be able to control all these sources and any interface or other devices required to control the lighting will be need provided as part of the base contract.
   5. Exterior Lighting: - Lighting on the exterior will not be dimmed (Unless note otherwise). It will be controlled by an astronomical timeclock that will automatically adjust on and off times throughout the year.

1.5 SYSTEM COMPONENT DESCRIPTION

A. System includes:
   1. Custom Combination Panel
   2. Dimming and switching panels; power interfaces and power modules
   3. Dimmable solid-state high frequency fluorescent EcoSystem dimming ballasts
   4. Dimmable LED modules via EcoSystem Drivers, 0-10V, DALI or other standard dimming protocol

1.6 SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Specification Conformance Document: Indicate whether the submitted equipment:
   1. Meets specification exactly as stated.
   2. Meets specification via an alternate means and indicate the specific methodology used.

C. Shop Drawings; include:
   1. Schematic (one-line diagram) of system.
   2. Product Data: Catalog cut sheets with performance specifications demonstrating compliance with specified requirements.
   3. Sequence of Operation to describe how each area operates and how any building wide functionality is described.
4. Manufacturer warranty to be included with system.

1.7 CLOSEOUT SUBMITTALS

A. Provide Operation and Maintenance Manuals:
   1. Including:
      a. Warranty Information
      b. System Start-up Information
      c. Installation Guide
      d. Set-up and Programming Guide
   2. Electronic format to be available on Lighting Control System manufacturer website.

1.8 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications:
   1. Company with not less than ten years of experience manufacturing lighting control systems of similar complexity to specified system.
   2. Registered to ISO 9001, including in-house engineering for product design activities.
   3. Qualified to supply specified products and to honor claims against product presented in accordance with warranty.

D. Maintenance Contractor Qualifications: Manufacturer's authorized service representative.

1.9 PROJECT CONDITIONS

A. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
   1. Ambient temperature: 0 degrees to 40 degrees C (32 degrees to 104 degrees F).
   2. Relative humidity: Maximum 90 percent, non-condensing.
   3. Lighting control system must be protected from dust during installation.
   4. Ambient temperature for Q-Manager, system computer: 10 degrees C to 35 degrees C (50 degrees F – 90 degrees F)

1.10 WARRANTY

A. Manufacturer's Standard Warranty, With Manufacturer Start-Up; Lutron Standard 2-Year Warranty; Lutron LSC-B2:
   1. Manufacturer Lighting Control System Components, Except Ballasts/Drivers and Ballast Modules:
      a. First Two Years:
         1) 100 percent replacement parts coverage, 100 percent manufacturer labor coverage to troubleshoot and diagnose a lighting issue.
         2) First-available on-site or remote response time.
         3) Remote diagnostics for applicable systems.
      b. Telephone Technical Support: Available 24 hours per day, 7 days per week, excluding manufacturer holidays.
   2. Ballasts/Drivers and Ballast Modules: Five years 100 percent parts coverage, no manufacturer labor coverage.

A. For ballasts, see section 26 50 10 – Light Fixtures.
   1. Ballasts and Drivers provided by control systems manufacturer shall be covered under their warranty.
a. Ballasts and Led Drivers shall be covered 100% for parts and labor for 5 years minimum.

PART 2- PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
   1. Lutron Electronics Co., Inc.
   2. Crestron Electronics, Inc.
   3. Acuity Lighting Controls

B. Basis of design product: Lutron Electronics Company

2.2 GENERAL

A. Lighting Controls: Ten-year operational life while operating continually at any temperature in an ambient temperature range of 0 degrees C (32 degrees F) to 40 degrees C (104 degrees F) and 90 percent non-condensing relative humidity.

B. Electrostatic Discharge Tolerance: Design and test equipment to withstand electrostatic discharges without impairment when tested according to IEC 61000-4-2.

2.3 DIMMING PERFORMANCE REQUIREMENTS

A. Electrolytic capacitors to operate at least 20 degrees C below the component manufacturer's maximum temperature rating when device is under fully-loaded conditions in 40 degrees C (104 degrees F) ambient temperature.

B. Load Handling Thyristors (SCRs and triacs), Field Effect Transistors (FETs), and Isolated Gate Bipolar Transistors (IGBTs): The component's maximum current rating to be at least two times the dimmer's/relay's rated operating current.

C. Capable of withstanding repetitive inrush current of 50 times operating current without impacting lifetime of dimmer/relay.

D. Design and test dimmers to withstand line-side surges without impairment to performance.
   1. Panels: Withstand without impairment of performance when subjected to surges of 6,000 volts, 3,000 amps per ANSI/IEEE C62.41 and per IEC 61000-4-5 surge requirements.
   2. Other power handling devices: Withstand surges without impairment of performance when subjected to surges of 6,000 volts, 200 amps per ANSI/IEEE C62.41.

E. Utilize air gap off to disconnect the load from line supply.

F. Power failure memory and dimmer/relay recovery:
   1. When power is interrupted and subsequently returned, within 3 seconds lights will automatically return to same levels (dimmed setting, full on, or off) prior to power interruption.

G. Dimmers:
   1. Provide real-time cycle-by-cycle compensation for incoming line voltage variations including changes in RMS voltage (plus or minus 2 percent change in RMS voltage/cycle), frequency shifts (plus or minus 2 Hz change in frequency/second), dynamic harmonics, and line noise.
   2. Systems not providing cycle-by-cycle compensation to include external power
conditioning equipment as part of dimming system.

3. Each dimmer to incorporate electronic "soft-start" default at initial turn-on that smoothly ramps lights up to the appropriate levels within 0.5 seconds.

4. Control all light sources in smooth and continuous manor. Dimmers with visible steps are not acceptable.

5. Load Types:
   a. Assign a load type to each dimmer that will provide a proper dimming curve for the specific light source to be controlled.
   b. Provide capability of being field-configured to have load types assigned per circuit.

6. Minimum and maximum light levels user adjustable on circuit-by-circuit basis.

7. Line Voltage Dimmers; Meet following load-specific requirements:
   a. Magnetic Low Voltage (MLV) transformer:
      1) Contain circuitry designed to control and provide a symmetrical AC waveform to input of magnetic low voltage transformers per UL 1472, Section 5.11.
      2) Dimmers using unipolar load current devices (such as FETs or SCRs) to include DC current protection in the event of a single device failure.
   b. Electronic Low Voltage (ELV) transformer:
      1) Dimmer to operate electronic low voltage transformers via reverse phase control. Alternately, forward phase control dimming may be used if dimming equipment manufacturer has recommended specific ELV transformers being provided.

8. Low Voltage Dimming Modules; Meet following requirements:
   a. Coordination between low voltage dimming module and line voltage relay: Capable of being electronically linked to single zone.
   b. Single low voltage dimming module; capable of controlling following light sources:
      1) 0-10V analog voltage signal.
         a) Provide Class 2 isolated 0-10V output signal conforming to IEC 60929.
         b) Sink current via IEC 60929.
         c) Source current.
      2) 10-0V reverse analog voltage signal.
      3) DSI digital communication.
      4) DALI broadcast communication IEC 60929:
         a) Logarithmic intensity values in compliance with IEC 60929.
         b) Linear intensity values for use with LED color intensity control.
      5) PWM IEC 60929.

H. Non-dim circuits to meet the following requirements:
   1. Rated life of relay at full load: Minimum 1,000,000 cycles.
   2. Load switched in manner that prevents arcing at mechanical contacts when power is applied to and removed from load circuits.
   3. Fully rated output continuous duty for inductive, capacitive, and resistive loads.

2.4 POWER PANELS

A. Product: Lutron CCP Series.

B. Provide power panels with configurations as indicated on the drawings.

C. Mechanical:
   1. Listed to UL 508 as industrial control equipment. CSA certified, or NOM approved as applicable.
   2. Delivered and installed as a [UL] [CSA] listed factory assembled panel.
   3. Field wiring accessible from front of panel without need to remove dimmer assemblies or other components.
4. Panels passively cooled via free-convection, unaided by fans or other means.

5. Ship panels with each dimmer in mechanical bypass position by means of jumper bar inserted between input and load terminals. Jumpers to carry full rated load current and be reusable at any time. Mechanical bypass device to allow for switching operation of connected load with dimmer removed by means of circuit breaker.

6. Provided with branch circuit protection for each input circuit unless the panel is a dedicated feed-through type panel or otherwise indicated on the drawings.

7. Branch Circuit Breakers:
   a. Listed to UL 489 as molded case circuit breaker for use on lighting circuits.
   b. Provided with visual trip indicator.
   c. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated and specified by Electrical Engineer
   d. Thermal-magnetic construction for overload, short-circuit, and over-temperature protection. Use of breakers without thermal protection requires dimmers/relays to have integral thermal protection to prevent failures when overloaded or ambient temperature is above rating of panel.
   e. Equipped with provision for tag-out/lock-out devices to secure circuit breakers in off position when servicing loads.
   f. Replaceable without moving or replacing dimmer/relay assemblies or other panel components.
   g. Listed as switch duty (SWD) so that loads can be switched on and off by breakers

8. Panel Processor; Lutron Circuit Selector:
   a. Provide the following capabilities:
      1) Operate circuit directly from panel processor for system diagnostics and provide feedback of system operation.
      2) Electronically assign each circuit to any zone in lighting control system.
      3) Determine normal/emergency function of panel and set emergency lighting levels.
   b. Where indicated on the drawings, panels to provide two control links. Each circuit to be capable of transferring control based on independent programming between architectural control system and theatrical controls utilizing the USITT DMX-512 1990 or ESTA DMX-512A protocol.
   c. React to changes from control within 20 milliseconds.

9. Diagnostics and Service:
   a. Replacing dimmer/relay does not require re-programming of system or processor.
   b. Include diagnostic LEDs for dimmers/relays to verify proper operation and assist in system troubleshooting.
   c. Include tiered control scheme for dealing with component failure that minimizes loss of control for occupant.
      1) If lighting control system fails, lights to remain at current level. Panel processor provides local control of lights until system is repaired.
      2) If panel processor fails, lights to remain at current level. Circuit breakers can be used to turn lights off or to full light output, allowing non-dim control of lights until panel processor is repaired.

10. If dimmer fails, factory-installed mechanical bypass jumpers to allow each dimmer to be mechanically bypassed. Mechanical bypass device to allow for switching operation of connected load with dimmer removed by means of circuit breaker.

D. Products:
1. Modular Combination Panels:
   a. Product: Lutron CCP Series Custom Combination Panels.
   b. Provide surface-mounted enclosures unless otherwise indicated.
   c. Unless otherwise indicated or required, utilize multiple load type 16 A feed continuous-use listed dimming/switching modules.
d. For switching only circuits, utilize relays rated for typical 1,000,000 cycles at fully rated 16 A for all lighting loads.

2. For loads requiring 0-10V, PWM, or DSI control, utilize compatible multiple load type low voltage dimming modules.

E. Diagnostics and Service:
   1. Replacing dimmer/relay does not require re-programming of system or processor.
   2. Dimmers/relays: Include diagnostic LEDs to verify proper operation and assist in system troubleshooting.
   3. Dimming/relay panels: Include tiered control scheme for dealing with component failure that minimizes loss of control for occupant.
      a. If lighting control system fails, lights to remain at current level. Panel processor provides local control of lights until system is repaired.
      b. If panel processor fails, lights to remain at current level. Circuit breakers can be used to turn lights off or to full light output, allowing non-dim control of lights until panel processor is repaired.
      c. If dimmer fails, factory-installed mechanical bypass jumpers to allow each dimmer to be mechanically bypassed. Mechanical bypass device to allow for switching operation of connected load with dimmer removed by means of circuit breaker.

2.5 LED DRIVERS

A. General Requirements:
   1. Designed for 10 year operational life while operating at maximum case temperature and 90 percent non-condensing relative humidity.
   2. Designed and tested to withstand electrostatic discharges without impairment when tested according to IEC 61000-4-2.
   3. UL 8750 recognized or listed as applicable.
   4. Complies with IEC 61347-2-13 as applicable.
   5. Surge Tolerance: Designed and tested to withstand Category A surges of 4,000 V according to IEEE C62.41.2 without impairment of performance.
   7. Class A sound rating; Inaudible in a 27 dBA ambient.
   8. No visible change in light output with a variation of plus or minus 10 percent line voltage input.
   9. Total Harmonic Distortion (THD): Less than 20 percent for loads greater than 25W; comply with ANSI C82.11.
   10. Drivers to track evenly across multiple lamp lengths and all light levels.
   11. Configuration tool available to optimize the following for LED fixtures:
      a. Light level.
      b. Efficacy.
      c. Thermal performance.

B. 3-Wire Control:
   1. Provide integral fault protection to prevent driver failure in the event of a mis-wire.
   2. Operate from input voltage of 120 V through 277 V at 60 Hz.

C. Digital Control:
   1. Lights automatically return to the setting prior to power interruption.
   2. Operate from input voltage of 120 V through 277 V at 60 Hz.
   3. Each driver responds independently to:
      a. Up to 32 occupant sensors.
      b. Up to 16 daylight sensors.
   4. Responds to digital load shed command. (Example: If light output is at 30 percent and a load shed command of 10 percent is received, the ballast automatically sets the maximum light output at 90 percent and lowers current light output by three percent to 27 percent).
D. Product(s):
1. Forward Phase (Neutral Wire Required), 3-Wire, and Digital Control, One Percent Dimming; Lutron A-Series:
   a. Dimming Range: 100 to one percent relative light output.
   b. Maximum Inrush Current: 2 amperes for 120V and 277V drivers.
   c. Constant Current Drivers:
      1) Support from 200 mA to 2.1 A (in 10 mA steps) to ensure a compatible driver exists.
      2) Support LED arrays up to 40W or 53 W (710 mA to 1.05 A in 10 mA steps).
   d. Constant Voltage Drivers:
      1) Support from 10 V to 60 V (in 0.5 V steps) to ensure a compatible driver exists.
      2) Support LED arrays up to 40W.

2.6 POWER INTERFACES

A. Provide power interfaces as indicated or as required to control the loads as indicated.

B. General Requirements:
1. Phase independent of control input.
2. Rated for use in air-handling spaces as defined in UL 2043.
3. Utilize air gap off to disconnect the load from line supply.
4. Diagnostics and Service: Replacing power interface does not require re-programming of system or processor.

C. Product(s):
1. Phase-Adaptive Power Module; Lutron PHPM-PA: Provides interface for phase control input to provide full 16 A circuit output of forward/reverse phase control for compatible loads.
2. 3-Wire Fluorescent Power Module; Lutron PHPM-3F: Provides interface for phase control input to provide full 16 A circuit output for compatible line-voltage control fluorescent electronic dimming ballasts.
3. Switching Power Module; Lutron PHPM-SW: Provides interface for phase control input to provide full 16 A circuit output of switching for compatible non-dim loads.
4. Phase-Adaptive Power Module with 3-Wire Fluorescent Input; Lutron PHPM-WBX: Provides interface for fluorescent ballast control input to provide full 16 A circuit output for compatible loads.
5. Ten Volt Interface; Lutron GRX-TV1: Provides interface for phase control input to provide full 16 A circuit output of switching and 0-10 V low voltage control for compatible fluorescent electronic dimming ballasts.

2.7 Main Units

A. Product: Lutron GRAFIK Eye QS.

B. Provide main units with configuration and quantity of zones as indicated or as required to control the loads as indicated.

C. Finish: Custom colors to be selected by Interior Designer

D. Engrave units with button, zone, and scene descriptions to be selected by Lighting Designer; or Owner / Operator.

E. Preset Lighting Control with Zone Override:
1. Intensity for each zone indicated by means of one illuminated bar graph per zone.
2. User-programmable zone and scene names.
3. Utilize air gap off to disconnect the load from line supply.
4. Astronomical time clock and programmer interface provides access to:
   a. Scene selections.
b. Fade zone to a level.
c. Fine-tuning of preset levels with scene raise/lower.
d. Lock out scenes and zones.
e. Fine-tuning of light levels with individual zone raise/lower.
f. Terminal block for wired infrared signal input.
g. Enable/disable wall station.

5. Light intensity with real time energy savings by digital display.
6. Fade time indicated by digital display for current scene while fading.
7. Integral wide angle infrared receiver.
8. For temporary local overrides, individual raise/lower buttons to allow zones to be adjusted without altering scene values stored in memory.
9. Direct Low-Voltage Control of Digital Ballasts and LED drivers (120V, 220/240V, 277V and/or 347V Lighting):
   a. Electronically link a digital fluorescent lighting ballast to a zone for both dimming and turning on/off.
   b. Electronically assign daylight sensors to digital ballasts and line voltage dimmers for proportional daylight harvesting.
   c. Single integral controller with Class 1 or Class 2 isolated digital output signal conforming to IEC 60929; capable of direct control without interface.
10. Creates daylighting rows independent of control zones.
11. Capable of re-zoning without re-wiring using programming display on unit.
12. Outputs can be virtually mapped to other device's outputs.
13. Zone raise/lower buttons capable of controlling local lighting loads connected to the main unit or remote lighting zones in the system.

The following module is designed for installation to a 4 inch by 4 inch junction box.

2.8 CONTROL STATIONS

A. Provide control stations with configuration as indicated or as required to control the loads as indicated.

B. Wired Control Stations:
   1. General Requirements:
      a. Class 2 (low voltage).
      b. UL listed.
      c. Control stations can be replaced without reprogramming.
      d. Finish: Custom colors to be selected by Interior Designer or Owner / Operator.
   2. Multi-Scene Wired Control:
      a. Product(s):
         1) Lutron seeTouch QS.
      b. Allows control of any devices part of the lighting control system.
      c. Utilize RS485 wiring for low-voltage communication.
      d. Functionality:
         1) Upon button press, LEDs to immediately illuminate.
         2) LEDs to reflect the true system status. LEDs to remain illuminated if the button press was properly processed or LEDs to turn off if the button press was not processed.
         3) Allows for easy reprogramming without replacing unit.
         4) Replacement of units does not require reprogramming.
      e. Provide faceplates with concealed mounting hardware.
      f. Engrave wall stations with button, zone, and scene descriptions to be selected by Lighting Designer; or Owner / Operator.
      g. Silk-screened borders, logos, and graduations to use graphic process that chemically bonds graphics to faceplate, resistant to removal by scratching and cleaning.
      h. Software Configuration:
         1) Customizable control station device button functionality:
            a) Buttons can be programmed to perform single defined action.
b) Buttons can be programmed to perform defined action on press and defined action on release.

c) Buttons can be programmed using conditional logic off of a state variable such as time of day or partition status.

i. Control station device LEDs to support logic that defines when it is illuminated:
   1) Scene logic (logic is true when all zones are at defined levels).
   2) Room logic (logic is true when at least one zone is on).
   3) Pathway (logic is true when at least one zone is on).
   4) Last scene (logic is true when spaces are in defined scenes).

j. Contact Closure Interface: Accepts both momentary and maintained contact closures.

2.9 LOW-VOLTAGE CONTROL INTERFACES

A. Provide low-voltage control interfaces as indicated or as required to control the loads as indicated.

B. UL listed.

C. Contact Closure Interface:
   1. Product: Lutron Model QSE-IO.
   2. The contact closure input device to accept both momentary and maintained contact closures.
   3. The contact closure output device can be configured for maintained or pulsed outputs.
   4. Contact closure can be programmed using conditional logic off of a state variable such as time of day or partition status.

D. Wallbox Input Closure Interface:
   1. Product: Lutron Model QSE-CI-WCI.
   2. Mounts in wallbox behind contact closure keypad to provide interface for up to eight contact closure inputs.
   3. The contact closure input device to accept both momentary and maintained contact closures.

E. RS232 and Ethernet Interface:
   1. Product: Lutron Model QSE-CI-NWK-E.
   2. Provide ability to communicate via Ethernet or RS232 to audiovisual equipment, touchscreens, etc.
   3. Allow creation of custom output strings.
   4. Provide control of:
      a. Light scene selections.
      b. Fine-tuning of light scene levels with raise/lower.
      c. Shade group presets.
      d. Fine-tuning of shade preset levels with raise/lower.
      e. Simulate system wall station button presses and releases.
   5. Provide status monitoring of:
      a. Light scene status.
      b. Shade group status.
      c. Wall station button presses and releases.
      d. Wall station LEDs.
   6. Provide ability to send custom output strings.

2.10 CONTROL STATIONS

A. System Wall Stations
   1. Allows controls of any devices part of the Lutron System.
   2. Product: WS 5 Button with Raise/Lower
   3. Electronics:
a. Use RS485 wiring for low voltage communication.

4. Functionality:
   a. Upon button press, LEDs to immediately illuminate.
   b. LEDs to reflect the true system status. LEDs to remain illuminated if the button press was properly processed or the LEDs turn off if the button press was not processed.
   c. Allow for easy reprogramming without replacing unit.
   d. Replacement of units does not require reprogramming.

5. Color:
   a. Custom color to be selected by Interior Designer
   b. Color variation in same product family: Maximum $\Delta E=1$, CIE $L^*a^*b^*$ color units.
   c. Visible parts: Exhibit ultraviolet color stability when tested with multiple actinic light sources as defined in ASTM D4674. Provide proof of testing upon request.

6. Provide faceplates with concealed mounting hardware.

7. Engrave wall stations in with appropriate button, zone, and scene engraving descriptions. Wall station labels to be customized with owner at project punch list. Project to ship WHH blank plates.

8. Silk-screened borders, logos, and graduations to use graphic process that chemically bonds graphics to faceplate, resistant to removal by scratching and cleaning.

2.11 SOURCE QUALITY CONTROL

   A. Perform full-function testing on all completed assemblies at end of line. Statistical sampling is not acceptable.

   B. Perform full-function testing on 100 percent of all ballasts at the factory.

   C. Audit burn-in at 40 degrees C (104 degrees F) ambient temperature of dimming assemblies and panels at full load for two hours.

   D. Perform burn-in at 40 degrees C (104 degrees F) ambient temperature on 100 percent of all ballasts at the factory.

PART 3 - EXECUTION

3.1 INSTALLATION

   A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130.

   B. Install products in accordance with manufacturer's instructions.

   C. Define each dimmer/relay load type, assign each load to a zone, and set control functions.

   D. Lamp Burn-In: Operate lamps at full output for prescribed period per manufacturer's recommendations prior to use with any dimming controls. Replace lamps that fail prematurely due to improper lamp burn-in.

   E. Lamp Lead Lengths: Do not exceed 7 feet (2.1 m) for T5, T5-HO, T8 U-bend, and T8 linear fluorescent lamps.

   F. LED Light Engine/Array Lead Length: Do not exceed 100 feet (31 m).

3.2 FIELD QUALITY CONTROL

   A. See Section 01 45 00 - Quality Control Services, for additional requirements.
B. Manufacturer's Startup Services; Lutron Standard Startup Services:
   1. Manufacturer's authorized Service Representative to conduct minimum of two site visits to ensure proper system installation and operation.
   2. Conduct Pre-Installation visit to review requirements with installer as specified in Part 1 under "Administrative Requirements".
   3. Conduct second site visit upon completion of lighting control system to perform system startup and verify proper operation:
      a. Verify connection of power wiring and load circuits.
      b. Verify connection and location of controls.
      c. Address devices.
      d. Verify system operation control by control.
      e. Verify proper operation of manufacturer's interfacing equipment.
      f. Configure initial groupings of ballast for wall controls.
      g. Train Owner's representative on system capabilities, operation, and maintenance, as specified in Part 3 under "Closeout Activities".
      h. Obtain sign-off on system functions.

C. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.

3.3 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.4 CLOSEOUT ACTIVITIES

A. See Section 01 77 00 – Contract Closeout.

B. See Section 01 7900 - Demonstration and Training, for additional requirements.

C. Demonstration:
   1. On-Site Performance-Verification Walkthrough; Lutron LSC-WALK: Include as part of the base bid.

D. Training:
   1. Include services of manufacturer's authorized Service Representative to perform on-site training of Owner's personnel on operation, adjustment, and maintenance of lighting control system as part of standard system start-up services.

3.5 PROTECTION

A. Protect installed products from subsequent construction operations.

END OF SECTION
### LIGHTING CONTROL SCHEDULE

**MWHarris Lighting Studio, LLC**

**14 Oregon Trail**

**Medford, NJ 08055**

**609 714 2449**

#### PROJECT: AC Hotel - Atlanta Airport

**ISSUE DATE:** 10.17.16

**ISSUED FOR CONSTRUCTION**

**260936 - Attachment #1**

**REVISIONS:**

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<th>AREA</th>
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> Provide (1) 5 Button R/L and DMX Control for CL2

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AREA LEVEL 1 - Bar

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PROJECT: AC Hotel - Atlanta Airport
ISSUE DATE: 10.17.16
ISSUED FOR CONSTRUCTION
260936 - Attachment #1

Note: Provide (1) 5 Button R/L and DMX Control for CL2.
## LIGHTING CONTROL SCHEDULE

### MWHarris Lighting Studio, LLC
14 Oregon Trail
Medford, NJ 08055
609 714 2449

### PROJECT: AC Hotel - Atlanta Airport
### ISSUE DATE: 10.17.16
### ISSUED FOR CONSTRUCTION

### 260936 - Attachment #1

**AREA** Level 1 - Breakfast Area

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<thead>
<tr>
<th>ROOM NO.</th>
<th>ZONE NO.</th>
<th>ZONE DESCRIPTION</th>
<th>NO. OF CIRCUITS</th>
<th>VOLTM.</th>
<th>FIXTURE TYPE</th>
<th>LOAD TYPE</th>
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<th>WATTS</th>
<th>TOTAL WATTS</th>
<th>CONTROL(S)</th>
<th>NOTE(S)</th>
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Provide (1) 5 Button R/L
### Lighting Control Schedule

**Lighting Control Studio, LLC**

**14 Oregon Trail**

**Medford, NJ 08055**

**609 714 2449**

**Area Level 1 - Meeting Room 107 (Provide with Partition Switch)**

Provide (2) 5 Button R/L and Control for GL2 Fixtures

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<th>No. of Circuits</th>
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</table>
PART 1 - GENERAL

1.01 SUMMARY

A. Provide all distribution switchgear as specified herein, as indicated on the Drawings and as required to provide a complete and operating system. All distribution equipment shall be of the same manufacturer including, but not limited to, switchboards, panelboards, transformers, disconnects, and busway.

B. The distribution equipment shall be designed, manufactured and tested in accordance with the latest version of the following standards:
   1. NFPA 70
   2. NEMA AB1
   3. NEMA KS1
   4. NEMA PB2
   5. NEMA PB1
   6. NEMA PB1.1
   7. NEMA PB2.1
   8. NEMA PB1.1
   9. NEMA 250
   10. NEMA TP-1-2002
   11. ANSI/IEEE C12.1
   12. ANSI C39.1
   13. ANSI C57.13
   14. UL 50, 67, 89, 98, 489
   15. ASTM

C. Provide nameplates for all distribution equipment as specified herein and per Section 26 05 50.

1.02 SUBMITTALS

A. The following data shall be submitted according to Section 01 33 00 and Section 26 01 00 and shall include but not be limited to:
   1. Physical dimensions, nameplate data, voltage, amperage, plan views, elevations, schematic wiring diagrams, bus capacities, circuit schedule, short circuit ratings, etc.
   2. The switchgear manufacturer shall provide a coordination study with settings of all over current protective devices. Over current protective devices shall be fully rated with selective coordination when applied in series with other devices.
   3. Over current protective devices serving life safety systems and elevators shall be fully rated with selective coordination when applied in series with other devices.
   4. The switchgear manufacturer shall provide an ARC Flash study. Provide labels on all switchboards, panels, and other electrical equipment as required per NEC 110.16.
   5. The ARC flash and coordination studies shall be performed in SKM software. A working SKM file shell be provided as part of the study so the owner can update study in the future with SKM software.

B. A ¼” scale dimensioned floor plan shall be provided with the switchgear submittals for all equipment rooms identifying actual size, clearance, access and spacing of the electrical equipment.

1.03 DELIVERY, STORAGE AND HANDLING
A. Deliver, store, protect, and handle products in conformance with manufacturer’s recommended practices as outlined in application installation and Maintenance Manuals.

B. Each switchboard section shall be delivered in individual shipping splits for ease of handling. They shall be individually wrapped for protection and mounted on shipping skids.

C. Inspect and report concealed damage to carrier within their required time period for repair or replacement.

D. Store in a clean, dry space. Maintain factory protection and/or provide an additional heavy canvas or heavy plastic cover to protect structure from dirt, water, construction debris, and traffic. Where applicable, provide adequate heating within enclosures to prevent condensation.

E. Handle in accordance with NEMA PB 2.1 and manufacturer’s written instructions. Lift only by lifting means provided for this express purpose. Handle carefully to avoid damage to switchboard internal components, enclosures, and finish.

1.04 ELECTRICAL SERVICE

A. Provide and install the building electrical service from the Power Company transformer(s) to the main service distribution equipment as shown on the Drawings. Any charges required by the Power Company for permanent power shall be included in this Contract.

B. Coordinate all installation requirements with the Power Company prior to bid and include all trenching, conduits, vaults, equipment pads, current transformers, potential transformers, potential taps as required. Coordinate all Work with the Power Company.

C. Provide conduit, C.T. enclosures, switchgear metering compartments, etc. as required by the Power Company for metering. Contractor shall coordinate all meter requirements with the Power Company prior to proceeding with this Work.

D. The secondary service to the building shall be 120/208 volts, 3 phase, 4 wire, 60 Hertz AC.

E. Provide (1) 1" conduit from each power company transformer to the telephone room and main service distribution equipment for pulse metering interface if available.

PART 2 - PRODUCTS

2.1 SWITCHBOARD

A. System Description
   1. Switchboards shall have a minimum short circuit rating of 65,000 amps RMS unless noted otherwise on the Drawings.
   2. Switchboard(s) shall have front access and rear alignment for mounting against a wall unless shown otherwise on the Drawings.

B. Standard Features
   1. Switchboards shall be fully self-supporting structures with 90 inch tall vertical sections (excluding lifting eyes and pull boxes) bolted together to form required arrangement. All sections shall be 36 inches deep unless shown otherwise on the Drawings. Switchboard depth shall be coordinated with room layout and adjusted accordingly to maintain required working clearances.
   2. Switchboard(s) shall be NEMA 1.
3. Switchboard frame shall be die formed, 12 gauge steel with reinforced corner gussets. Frame shall be rigidly bolted to support cover plated (code gauge steel), bus bars and installed devices during shipment and installation.

4. All sections may be rolled, moved or lifted into position. Switchboards shall be capable of being bolted directly to the floor without the use of floor sills.

5. All switchboard sections shall have open bottoms and removable top plates(s) to install conduit.

6. Front-Access only switchboard sections shall be rear aligned for placement against a wall. Provide front and rear accessible switchboards where both front and rear access is shown to be available on the Drawings.

7. Switchboards shall be UL listed to accept a combination of circuit breakers and/or fused switches, where applicable, factory or field installed.

8. Switchboards that are series rated to short circuit requirements shall be appropriately labeled. Tested UL listed combination ratings shall be included in UL recognized Component Directory (DKSY2).

9. All covers shall be fastened by hex head bolts.

10. Provide hinged doors over metering compartments and individually mounted device compartments. All doors shall have concealed hinges and be fastened by hex head bolts.

11. Switchboards protective devices shall be provided as listed on Drawings and specified herein, including interconnections, instrumentation and control wiring. Switchboards and devices shall be rated for the voltage and frequency as shown on the Drawings.

12. Switchboard current ratings, including all devices, shall be based on a maximum ambient temperature of 25 degree C per UL Standard 891. With no derating required, temperature rise of switchboards and devices shall not exceed 65 degrees C in a 25 degree C ambient environment.

13. Switchboard Service Entrance sections shall comply with UL Service Entrance requirements including UL service entrance label, incoming line isolation barriers, and a removable neutral bond to switchboard ground for solidly grounded wire systems.

14. Construction shall allow for the maintenance of all terminations, device connections and bolted bus connections.

15. Provide all spare spaces and circuit protective devices as indicated on the Drawings. All unused spaces provided, unless otherwise specified, shall be fully equipped for future devices, including all appropriate connectors and mounting hardware.

16. Provide all necessary wiring, fuse blocks and terminal blocks within the switchboard as required. All groups of control wires shall be provided with terminal blocks with numbering strips.

17. Provide nameplates for each switchboard and each overcurrent device in accordance with Section 26 05 50 “Electrical Identification”.

18. Switchboard enclosures and structure shall be painted on all sides after fabrication with enamel over a rust-inhibiting primer coat or protected by an electro-deposition or powder coat paint process.

C. Bus Bars

1. Bus bars shall be silver-plated copper or tin-plated aluminum. Plating shall be applied continuously to all buswork. The bus bars shall have sufficient cross sectional area to meet UL 891 temperature rise requirements through actual tests. Phase and neutral bus ampacity shall be as shown on the plans. The neutral bus shall have the same ampacity as the phase bus.

2. Bus bars shall be mounted on high impact, non tracking insulated supports. Joints in the vertical bus are not permitted.

3. Bus bars shall be braced to withstand mechanical forces exerted during short circuit conditions as indicated in Drawings, but in no case less than 65KA RMS SYM.

4. Bus joints shall be bolted with high tensile steel bolts. Belleville type washers shall be provided with aluminum bus. Welded connections are unacceptable.
5. Main horizontal bus bars shall be fully rated and arranged for future extensions. Full provisions shall be provided for the addition of future sections. Bussing shall include all necessary hardware to accommodate splicing for future additions.

6. A-B-C bus arrangement (left to right, top to bottom, front to rear) shall be used throughout to assure convenient and safe testing and maintenance. Where special circuitry precludes this arrangement, bus bars shall be labeled.

7. All feeder device line and load connections traps shall be rated to carry current rating of device frame (not trip rating).

8. The main incoming bus bars shall be rated for the main protection device frame size or main incoming conductors, if there is no main device.

9. Ground bus shall be sized to meet UL 891. Ground bus shall extend full length of switchboard. Provisions for the addition of future connections and future sections shall be provided as previously indicated.

10. The horizontal and vertical main bus bars shall remain full size throughout their full length. Bus reductions other than those indicated on the Drawings are not acceptable.

11. Where “space” is provided or indicated on the Drawings, the space shall be bussed.

D. Main Incoming Compartment

1. Provide switchboard(s) arranged for bottom entry of incoming cable or top entry of incoming cable, whichever is indicated on Drawings.
   a. All lugs shall be tin-plated aluminum and UL listed for use with copper cable. Lugs shall be rated for 75 degree C cable.

2. Provide pull section adjacent to the incoming section as indicated on the Drawings. Transient suppression shall be factory mounted in the pull section of each switchboard with minimum lead lengths as indicated on the Drawings. See Transient Suppression specification Section 26 43 04.

E. Main and Feeder Devices

1. Main device shall be individually mounted, insulated case circuit breaker. Provide device as shown on the Drawings and as specified in appropriate article below.

2. Feeder devices shall be group mount molded case circuit breakers or when larger than 1200 amps shall be individually mounted insulated case circuit breakers. Provide devices as specified in appropriate article below.

3. All circuit protective devices minimum symmetrical current interrupting capacity shall be as shown on the Drawings, but on no case less than 65KA RMS SYM.

4. All main breakers and feeder breakers 1200A or larger shall be connected to an energy reducing maintenance switch with indicator light. Device shall comply with NEC Article 240.87.

F. Molded Case Circuit Breakers

1. Thermal magnetic molded case circuit breakers may be provided for trip ratings 160 amps and below.

2. Group mounted breakers shall be modular mounted. The module shall be electrically connected to the switchboard bus by spring reinforced jaws. Mechanical connections to panel frame shall be separate from electrical connections. Mechanical connections shall be self-aligning, spring loaded locking devices. Locking device handles shall be able to be bolted to each side of the device to prevent accidental release of electrical connections.

3. Individually mounted molded case circuit breakers shall be stationary mounted.

4. Circuit breaker frames shall be constructed of a high-strength, molded, glass-reinforced polyester case and cover. Breakers shall have an overcenter, toggle handle-operated, trip free mechanism with quick make, quick break action independent of the speed of the toggle handle operation. The design shall provide common tripping of all poles. Breakers shall be suitable for reverse feeding.

5. Breakers shall have ON and OFF positions clearly marked on escutcheon. Breakers shall include a trip-to-test means on the escutcheon for manually tripping the breaker and exercising the mechanism and trip latch.
6. Breakers shall include factory installed mechanical lugs. Lugs shall be UL listed and rated 75 degrees C. Breakers shall be standard, or 80 percent rated.
7. Each feeder breaker with a frame size 150 amps and larger shall have a digital electronic trip unit as described below.
8. Where indicated on the Drawings, circuit breakers with trip ratings greater than 250 amperes to 1000 amperes shall be UL listed as 100% continuous duty rated.

G. Insulated Case Circuit Breakers
1. Insulated case circuit breakers shall be individually mounted.
2. Main breakers shall be manually operated, stationary mounted. Feeder breakers (larger than 1200 amps) shall be manually operated, stationary mounted.
3. Breakers shall be constructed of a high dielectric strength, glass reinforced insulating case. The interrupting mechanism shall be arc chutes. Steel vent grids shall be used to suppress arcs and cool vented gases. Interphase barriers shall be used to completely isolate each pole.
4. Breakers shall contain a true two-step stored energy operating mechanism which shall provide quick make, quick break operation with a maximum five cycle closing time. Breakers shall be trip free at all times. Common tripping of all poles shall be standard.
5. Insulated Case circuit breakers shall be rated to carry 100 percent of their frame ampacity continuously.
6. A charging handle, close push-button, open push-button, and OFF/ON/Charge indicator shall be located on the breaker escutcheon and shall be visible with the breaker compartment door closed.
7. Each main breaker shall have a digital electronic trip unit as described below.

H. Drawout Mounted
1. Provide individually mounted and/or group mounted drawout breakers as shown on the Drawings.
2. Sturdy drawout rails shall be permanently attached to the sides of the breaker compartment and retract into the compartment when not in use.
3. When fully withdrawn, the circuit breaker shall permit access for inspection and testing.
4. Circuit breaker(s) shall also be removable from the rails completely.
5. When the circuit breaker is in the “Connected”, “Test” or “Disconnect” positions, or when the circuit breaker is removed from the compartment, the compartment door shall be able to be fully closed and secured.
6. A removable crank shall be supplied with each Drawout Switchboard for racking the circuit breaker between the “Connected”, “Test”, and “Disconnect” positions.
7. The breaker main contacts shall only be closed when the breaker is in the “Test” position, or fully seated in the “Connected” position.
8. The control contacts shall be automatically engaged in the “Connected” and “Test” positions, and automatically disengaged when the breaker is in the withdrawn position.
9. Mechanical interlocking shall prevent racking a closed breaker and no permit closing the breaker contacts while the element is between positions.

I. Digital Electronic Trip Unit for Circuit Breakers
1. Provide digital electronic trip units as specified below.
2. Each main and feeder circuit breaker 400A and above shall be equipped with a digital electronic trip unit. The trip unit shall provide protection from overload, short circuits and ground faults. The protective trip unit shall consist of a solid state, microprocessor based programmer, tripping means, current sensors, power supply and other devices as required for proper operation.
3. As a minimum, the trip unit shall have the following protective functions:
   a. Adjustable current setting or long time pickup;
   b. Adjustable long time delay;
   c. Adjustable instantaneous pickup;
   d. Adjustable ground fault pickup and delay for main and designated feeders;
e. Adjustable short time pickup and delay for main and designated feeders.

4. As a minimum, the trip unit shall include the following features:
   a. Long time and short time protective functions, if provided, shall have true RMS sensing technology.
   b. Ground fault protective function, if provided, shall contain a memory circuit to integrate low level arcing fault currents with time, to sum the intermittent ground fault spikes.
   c. High contrast liquid crystal display (LCD) unit shall display settings, trip targets, and the specified metering displays.
   d. Multi-button keypad to provide local setup and readout of all trip settings on the LCD.
   e. UL listed interchangeable rating plug. It shall not be necessary to remove the trip unit to change the rating plug.
   f. An integral test jack for testing via a portable test set and connection to a battery source.
   g. A mechanism for sealing the rating plug and the trip unit.
   h. Noise immunity shall meet the requirement of IEEE C37.90.
   i. Display trip targets for long time, short time, and ground fault, if included.

5. The main breakers’ trip unit shall include the following metering functions, which shall be displayed on the LCD (if the manufactures trip unit cannot incorporate the specified functions, separate device(s) with equal function shall be provided for each breaker):
   a. Current, RMS, each phase;
   b. Voltage, RMS, line-to-line, or line-to-neutral;
   c. Energy, KWH, total;
   d. Demand KWH, over an adjustable time period of 5 to 60 minutes;
   e. Peak demand, KW, user resettable;
   f. Real power, KW, line-to-line, line-to-neutral;
   g. Total (apparent) power, KVA, line-to-line, line-to-line neutral.

6. All main breaker trip units shall have communication capability.

J. Ground Fault Protection
   1. An adjustable ground fault protection system shall be provided as an integral part of the main circuit breaker or main fused switch, designated feeder breakers and fused switches where indicated on the Drawings and/or required by Code.
   2. The ground fault protection system shall consist of a current sensor enclosing all phase and neutral conductors of the circuits to be monitored, appropriate relaying equipment to provide the desired ground current sensitivity and time-current response characteristics, and equipped to function in conjunctions with the other elements of the system.
   3. The current sensor shall be of sufficient size to encircle the phase and neutral conductors of the circuit to be monitored. Current sensor output shall be coordinated with the required input to the delay. The current sensor shall have a ground fault current pick-up range of 200 to 1200 amperes. A test winding shall be included to simulate the flow of ground fault current through the sensor to test the operation of the ground fault protection system. The frame of the current sensor shall be constructed so that one leg can be opened to allow removal or installation around cable without disturbing that cable.
   4. The ground fault relay shall be solid state construction, except that a coil operated output relay may be provided to control 120 volt power to operate a fusible bolted pressure contact switch. The relay shall have an adjustable current sensitivity for ground fault pick-up currents from 200 amperes to 1200 amperes.
   5. Provide a ground fault integral to trip unit or provide separate monitor panel on the switchboard with a push-to-test button for the test circuit and a red ground fault indicator light to indicate the circuit interrupter has opened due to a ground fault condition. The unit shall operate on a 120 volt AC source.
   6. Provide a LCD display or red LED light indicator that is activated when a ground fault condition occurs. The light shall be deactivated when the system is reset and the fault is cleared.
   7. The ground fault system shall be tested in accordance with manufacturer’s recommendations as required by NEC Article 230.95C
K. Metering Transformers
1. All instrument transformers shall be UL listed and classified as indicated in Drawings.
2. Current Transformers shall be provided with burden and accuracy to support connected meters and relays as required by [ANSI/IEEE C57.13].
3. Potential transformers shall be provided with burden and accuracy to support connected meters and relays as required by [ANSI/IEEE C57.13].

L. Accessories
1. Provide Taylor Electronics Model #PND-3, 6, 9, 12 ADJ-REM LED’s or equal, single phase relay behind hinged panel in switchboard. Provide green and amber LED’s on a plug in cable for mounting on face of switchboard. Provide snap on lenses and labels identifying the green LED as “SYSTEM NORMAL” and the amber LED as “SINGLE PHASE CONDITION”.
2. Provide shunt trip coils on all main devices, operated by the phase failure relay.
3. Provide capacitive trip unit to guarantee relay and shunt trip operation during a single phase occurrence.

M. Main switchboard shall be as manufactured by General Electric, Square D, Cutler-Hammer and Siemens.

2.02 PANELBOARDS

A. System Description
1. Short circuit rating of panelboards shall be the interrupting rating of lowest rated device in the panel or application UL series for proper main and branch device combinations.
2. Panelboards shall have a maximum of 42 protective devices per panel, including sub-feeders and excluding main overcurrent protective devices. For more than 42 devices, 2 or more panelboards are required.
3. With 2 or more panelboards, sub-feed lug or thru-feed lugs shall be used in all by 1 section of each panelboard. Lugs shall have same capacity as incoming mains.
4. Protective devices shall be molded case circuit breakers.

B. Enclosure
1. Boxes shall be a nominal 20 inches wide and 6 inches deep with wire bending space per the National Electric Code.
2. Fronts shall be door-in-door construction reinforced steel with concealed hinges and concealed trim adjusting screws. Trim clamps are unacceptable.
3. All door locks shall be corrosion proof Valox (or equal) with retractable latches. All door locks shall be keyed for a single key.
4. Clean Lexan (or equal) directory card holders shall be permanently mounted on front door.
5. All panelboard series ratings shall be prominently displayed on dead front shield.
6. Interiors shall permit top or bottom incoming cables.

C. Bus bars
1. Bus bars shall be copper, phase sequenced, fully insulated and supported by high impact Noryl (or equal) interior base assemblies.
2. Bus bars shall be mechanically supported by zinc finished galvanneal steel frames to prevent vibration and damage from short circuits.
3. Terminations shall be UL tested and listed and suitable for UL copper.
4. Provide 1 continuous bus bar per phase. Each bus bar shall have sequentially phased branch circuit connectors for bolt-on branch circuit breakers. Bus bars shall be rated as indicated in Drawings.
5. Split solid neutral bus shall be plated and located in main compartment for all incoming neutral cables to be same length. 200% rated solid neutral shall be provided as indicated on the Drawings and shall be plated copper for non-linear load applications subject to harmonics. 200% rated solid neutral shall be self-certified by Manufacturer.
6. Lugs shall be rated for 75 degree C terminations.
7. Interiors shall be field convertible for top or bottom incoming feed. Main and sub-feed circuit breakers shall be vertically mounted. Main lug interiors up to 400 amperes shall be field convertible to main breaker. Interior leveling provisions shall be provided for flush mounted applications.

8. Log bodies shall bolt in place.

D. Circuit Breakers
1. Molded case circuit breakers shall be bolt-in devices for 120/208V panels and 277/480V panels.
2. All circuit breakers shall have thermal and magnetic trip elements in each pole.
3. Multiple pole breakers shall have internal common trip crossbars for simultaneous tripping of each pole.
4. Circuit breakers shall not be restricted to any mounting location due to physical size.
5. All branch breakers 15 to 100 amperes shall be able to be mounted in any panel position for twin or double mounting without space penalty. Sum of ratings for 2 such twin mounted devices shall not exceed 180 amperes.
6. Main and sub-feed circuit breakers may be vertically or horizontally mounted.
7. Branch breaker panelboard connections shall be copper to copper.
8. All panelboard terminations shall be rated as indicated in Drawings.
9. All breakers shall have an over center mechanism and be quick make and quick break.
10. All breakers shall have handle trip indication and a trip indicator in window of circuit breaker housing.
11. Breaker handle and faceplate shall indicate rated ampacity.
12. Circuit breaker escutcheon shall have standard ON/OFF markings.
13. Main breakers shall be UL listed for use with: Shunt, Under Voltage, and Ground Fault Shunt Trips; Auxiliary and Alarm Switches; and Mechanical Lug Kits.
14. Branch breakers shall be UL listed for use with: Shunt Trips, Auxiliary and Alarm Switches.

E. Finish
1. Boxes shall be corrosion resistant, zinc finish galvanneal.
2. Fronts shall be powder finish painted ANSI 61 gray.

F. Panels shall be manufactured by General Electric, Square D, Cutler-Hammer or Siemens.

2.03 DISTRIBUTION PANELBOARDS

A. System Description
1. Equipment shall be indoor deadfront power panelboards for molded-case circuit breakers.
2. Panelboards shall meet service entrance equipment where indicated on the Drawings.
3. Panelboards shall have integrated short circuit rating. Fully rated panel rating is that of lowest rated device in panelboard. Series ratings are for the UL tested main-branch combination.

B. Enclosures
1. Panel box shall be galvanized code gauge sheet steel with removable end walls.
2. Enclosures shall be surface mounted.

C. Fronts
1. Provide a four-piece front to cover wiring gutter and wiring access areas. Provide a lockable hinged door with semi-concealed hinges to cover access to circuit breakers.
2. Hinged door fronts, when specified, shall be provided with a lockable inner door with leaf hinges. An inner door shall cover the circuit protective devices and shall be able to be locked.
3. Door hinges shall be continuous piano hinges, welded to door(s) and bolted on front.
4. Door locks shall be Yale #511.
D. Interiors
1. Panelboard interior shall be symmetrically designed and assembled such that circuit protective modules are connected onto bus bar with positive gripping jaw assemblies and locked pressure connections.
2. Circuit-protective modules shall be designed for removal or replacement without disturbing adjacent protective devices and without removing main bus and branch circuit connections.
3. Interiors shall allow installation of molded-case circuit breakers in same panelboard.
4. Lugs shall be UL listed to accept solid or stranded copper cables. Lugs shall be bolted in place.
5. Panelboards shall be rated as indicated in Drawings. Main devices shall have maximum rating of 1200 amperes.
6. Panelboards shall have flat, stacked, vertically aligned bus bars.
7. Bus bars shall be copper. The bus bars shall have sufficient cross sectional area to meet UL 67 temperature rise requirements through actual tests. The bus bars shall be standard density rated for 1000 amperes per square inch.
8. Bus bars shall be phase-sequenced and rigidly supported by high impact resistant, insulated bus supporting assemblies to prevent vibration or short circuit mechanical damage.
9. Neutral bus shall be fully rated and able to be located in either corner of enclosure at line end to facilitate conductor termination. Provide 200% rated neutral bus, if required by plans or another specification section.
10. All solderless terminations shall be suitable for copper UL listed wire or cable and shall be tested and listed in conjunction with appropriate UL standards. Terminations shall be rated for use with conductor ampacity as assigned in the NEC 75 degree C table.
11. Ground wire terminations shall be provided as an optional kit for installation by panelboard installer without voiding UL label.

E. Main and Branch Devices
1. Circuit breakers
   a. Main and branch circuit breaker shall be quick-make, quick-break, and trip indicating, low voltage molded-case.
   b. Circuit breaker case shall have ON/OFF and International I/O position indicators.
   c. Breaker faceplate shall list current rating, UL and IEC certification standards, and AIC ratings.
   d. Circuit breakers shall be factory sealed and shall be date coded on breaker case.
   e. Breakers shall be UL listed for reverse connection without restrictive line or load markings. Circuit breakers shall be able to mount in any operating position.
   f. 3-pole breakers with ampere ratings greater than 150 ampere shall have rating plugs.
   g. All circuit protective devices shall have the following minimum symmetrical current interrupting capacity of 18kA. Interrupting rating of breakers shall not be less than maximum short circuit current available at incoming line terminals as shown on plans.
   h. Breakers shall have UL listed series ratings, if specified in Drawings.
   i. Main breakers and lugs shall be convertible by installer for top or bottom incoming feed.
   j. Where indicated on the drawings, elsewhere in the specifications, or as required for coordination, the main breaker shall be provided with integral ground pick-up and delay settings and adjustable long time, instantaneous and short time settings.
   k. All main breakers and feeder breakers 1200A or larger shall be connected to a energy reducing maintenance switch with indicator light. Device shall comply with NEC Article 240.87.

F. Series Ratings
1. Panelboard series-connected ratings shall be attached to the panelboard enclosure.

G. Distribution panels shall be manufactured by General Electric, Square D, Cutler-Hammer or Siemens.

2.04 TRANSFORMERS
A. System Description
   1. Power transformers shall be 2 winding dry type for general power and lighting applications. Transformers rated 1000 KVA or below shall be UL listed, DOE 2016 efficiency standard, and bear required UL Listing Mark.

B. Dry-type general purpose transformers shall be rated as indicated in Drawings.

C. Transformers shall use properly classified UL approved temperature ratings. Temperature rise ratings shall be in accordance with UL 506. Insulation ratings shall be as indicated in Drawings.

D. Transformers shall be UL recognized 200 degree insulation system and shall be designed so that under full load the average conductor temperature rise does not exceed 115 degrees C rise above a 40 degree C ambient and the enclosure does not exceed a 50 degree C rise at any point.

E. Transformers 5 KVA and above shall be able to meet ANSI/IEEE C57.96 daily overload requirement listed in Drawings. Transformers loaded in accordance with this paragraph shall be capable of long service life under thermal conditions specified. There shall be no need for derating.

F. Transformers shall have sound levels equal to or lower than those established in latest revision of ANSI/IEEE C89.2 as shown in drawings.

G. Enclosures shall meet UL 506 requirement for the following characteristics:
   1. Ventilation Openings;
   2. Corrosion Resistance;
   3. Cable Bending Space;
   4. Surface Temperature Rise;
   5. Wiring Compartment Temperature Rise;
   6. Terminations;

H. Transformer Construction
   1. Transformer cores shall be constructed of high grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Magnetic flux densities shall be kept well below core saturation point. Core laminations above 112.5 KVA shall be miter cut at core corners to reduce hot spots, core loss, current and sound level. Core laminations shall be clamped together with steel angles. Cores for transformers above 300 KVA shall be clamped using insulated bolts through core laminations to provide proper pressure throughout core length. Completed core and coil shall be bolted to enclosure base and isolated from base by rubber vibration-absorbing mounts. There shall be no metal-to-metal contact between core and coil and enclosure. Sound isolation systems requiring complete removal of all fastening devices is not acceptable.
   2. Transformer core shall be visibly grounded to enclosure by flexible grounding conductor meeting UL and NEC size requirements.
   3. Enclosure shall be constructed of heavy gauge steel.
   4. Coils shall be copper.

I. Load Taps
   1. Transformers shall have following high voltage load tap arrangements unless noted otherwise in plans:
      a. Through 2 KVA – no taps;
      b. Through 23 KVA – no taps;
      c. 3 through 23 KVA 2 above, 2 below nominal 4, 2-1/2 percent taps voltage;
      d. Through 500 KVA – 6, 2-1/2 percent taps, 2 above, 4 below nominal voltage.
J. Finish
   1. Finish shall consist of degreasing, phosphate cleaning, and electrodeposits ANSI gray enamel paint.

H. Transformers – standard shall be as manufactured by General Electric or Square D, Cutler-Hammer or Siemens.

2.05 BUSWAY

A. System Description
   1. Busway shall be a totally enclosed, indoor low-impedance system.
   2. Material and installation shall comply with all applicable codes, recommended practices, and standards of ANSI, IEEE, NEMA, UL, CSA, and ASTA. All busway components shall be UL listed. Arrangements, details, and location shall be as indicated in Drawings. Busway shall be tested and conform to Seismic Zone 4 requirements.
   3. Short circuit rating of fittings with protective devices shall be equal to the lower short circuit rating of the protective device or the busway. Short circuit rating of busway plugs equals the rating of the fuses of circuit breaker used in the plug.

B. Busway housing shall be extruded aluminum for maximum protection against corrosion from water and other contaminants normally encountered during construction. Housing shall be totally enclosed for protection against mechanical damage and dust accumulation. All hardware shall be plated to prevent corrosion.

C. All bus insulation material shall be epoxy NEMA Class B (130 degree C). Insulation shall be UL rated as self-extinguishing and shall be impervious to acids, alkalis, acetones, machine oils and lubricants commonly found in industrial environments. Manufacturer shall provide test data documenting insulation’s impact resistance, chemical resistance, and expected life (50 years).

D. Busway shall be rated as indicated in Drawings.

E. Bus bars shall be 98% conductivity copper or silver-plated aluminum. Temperature rise at any point in busway shall not exceed 55 degrees C above ambient when operating at rated load current.

F. If housing ground path is used, system connections shall be silver plated.

G. Hanger System
   1. Horizontal busway runs shall be UL listed to hang on 10 foot centers in any position. Vertical busway riser runs shall be supported with spring hangers.

H. Where busway passes through walls or floors, manufacturers shall, at user’s request, provide UL-Listed three-hour firestop system [No. 539], GE PENSIL 100 or 500 (or equal).

I. Joints shall have plus or minus ½ inch adjustability and be the one-bolt removable type. Joints shall be able to be made from one side when busway is installed against a wall or ceiling. Plug-in and feeder shall use identical parts. All multi-stack shall be phase collected.

J. Plug-in busway shall be identical to feeder construction and performance except it shall have 5 dead-front hinged cover type plug outlets per side per 10 foot length. All outlets shall be usable simultaneously.

K. Plug-In Unit Safety Device
   1. Busway plugs shall be of the type(s) and rating listed in Contract. Switching device(s) shall be completely enclosed in sheet steel housing.
2. Shields shall protect stabs and ground plug body and shielding to prevent access to live parts when cover is open. A ground stab shall engage ground tab on busway and internal ground bus shall be provided when required.

3. Cover and operating handle shall have provision to padlock in OFF position. Operating handle shall be easily moved from end to side or vice versa.

4. A releasable cover interlock shall prevent opening cover except when switch is OFF.

5. Operation switch type plugs shall have a positive quick-made, quick-break interrupter. Circuit breaker plugs shall have true RMS electronic sensing and an interrupting rating of at least the available amperes RMS indicated on the plans, with interchangeable rating plugs.

L. Short Circuit Ratings
   1. The short circuit rating of the busway, including its integral fittings and protective devices, shall be the lowest of the short circuit ratings of the busway, its fittings or protective devices. For example, a fusible power takeoff rated 200,000 amperes with Class J fuses is installed on a 65,000 ampere rated busway. The rating of this system is 65,000 amperes.

M. Accessories
   1. Thermal expansion fittings for:
      a. Runs longer than 150 feet when busway is not free to move at ends of run;
      b. When busway run crosses building expansion joint.
   2. Reducer cubicles and special adapter cubicles, as required in Drawings.
   3. Provide Joint-Guard Protective System that uses a “torque sensing bolt”. The system shall measure the “elongation of the busway joint bolt”. When the bolt loses proper torque, a “red indication shall appear in the bolt head”. After re-torquing the bolt, the red indication shall recede and the bolt head shall return to normal color. The system shall be “self renewing” without bolt replacement.

N. Finish
   1. ANSI-61 gray enamel.

O. Installation
   1. Provide floor or wall flanges at all fire separations as required. Coordinate installation of floor flanges and firestop systems with waterproof curbs.
   2. All busway joints shall be torqued as recommended by the manufacturer. A recheck of torque setting shall be made by the Electrical Subcontractor after the busway has been in service and subjected to varying load conditions. The Electrical Subcontractor shall submit a report of this recheck to the Owner upon completion.
   3. All connections to bus switches shall be made with flexible meal conduit. No “hard-pipe” connections to bus switches are allowed. All bus switch connections shall be in place prior to final adjustment and isolation of all vertical bus risers.

P. Busway Hangers and Supports
   1. All horizontal busways throughout the building shall be thoroughly and substantially supported in accordance with the National Electrical Code. Busways may be supported individually with approved hangers or in groups using Unistrut and hangers. Hangers shall not be spaced more than ten (10) feet apart. Additional hangers shall be provided where required by the manufacturer or the local Authority having jurisdiction. Busway shall be attached to the hanger supports. Perforated extension hangers will not be accepted in any part of the Work.
   2. All vertical busways shall be substantially supported at each floor line to carry the weight of the busway in a satisfactory manner, with allowance for expansion and contraction. Installation shall comply with the manufacturer’s requirements including maximum and minimum spring hangar deflection, expansion section tolerances, and torque settings. Coordinate installation of hangers and supports with waterproof curbs provided under another Division.
3. Special hangers and supports shall be provided where they may be required because of any peculiarities of construction. Adequate space shall be provided between adjacent busways to provide for maintenance of joints.

4. Hanger rod sizes shall be recommended by the hanger and/or busway manufacturer for the service intended.

Q. Busway shall be as manufactured by General Electric, Square D, Cutler-Hammer or Siemens.

2.06 DISCONNECT SWITCHES

A. Switches shall be heavy-duty type. The switch blades shall be visible when the switch is OFF and the cover is open. Lugs shall be front removable and UL listed for 75 degrees C conductor. Provide removable arc suppressor to facilitate easy access to line side up.

B. Switches shall have provisions for a field installable electrical interlock.

C. The switch operating mechanism shall be quick-make, quick-break.

D. Provide padlock provisions for locking in the OFF position.

E. Provide NEMA type enclosure suitable for the application (indoor, outdoor, wet or damp, corrosive, etc.). Type 3R enclosure shall contain no knockouts (supply watertight hubs).

F. Enclosure shall have ON and OFF markings stamped on the enclosure.

G. Switches shall be horsepower rated.

H. Fused disconnect switches shall have rejection type fuse clips with dual element current limiting fuses of rating shown or required by the Manufacturer’s nameplate of the equipment being supplied. The UL short circuit rating shall be 200,000 amps RMS SYM when used with Class R or J fuses.

2.07 FUSES

A. Fuses shall have 200,000 Amp RMS SYS rating.

B. Fuses for circuits 1 to 600 amperes shall be dual element, current limiting time delay (500% of rated current for minimum of 10 seconds) with separate overload and short circuit clearing chamber. Bussman “Low Peak” or equal by Littlefuse or Ferraz Shawmut. UL Class J.

C. Fuses for circuits above 600 amperes shall be current limiting, time delay (500% of rated current for minimum of 4 seconds, clear 20 times rated current in 0/1 seconds or less). Bussman, “Hi-Cap” or equal by Littlefuse or Ferraz Shawmut. UL Class L.

D. Provide one (1) set of spare fuses for each set of three (3). A maximum of three (3) sets of fuses is required to be provided for the same type and rating.

PART 3 - EXECUTION

3.01 GENERAL

A. Clean all enclosures free of all foreign matter and dust.

B. Remove all rust marks and repaint to new condition.
C. Provide all necessary hardware to level and secure all switchgear.

D. Provide engraved nameplates on all switchgear per Section 26 05 50 including but not limited to, switchboards, switchboard overcurrent protection devices, panelboards, distributor panelboards, disconnects, contactors, busway, busplugs.

E. Provide a typewritten directory for all panelboards. Make spares in pencil.

3.02 FIELD TESTING

A. Infra-red Testing
   1. After the electrical distribution system has been checked, adjusted, calibrated and under load just prior to substantial complete, it shall be subjected to an infra-red thermograph test by a NETA certified technician. The test shall be performed with a minimum load of 20% of the rating of the equipment/connection being tested. Load banks shall be supplied if necessary to provide this load factor.
   2. Two (2) copies of the test report shall be provided to the Engineer upon completion of the test. Connections indicated having higher temperatures than acceptable shall be tightened or corrected as required. After corrections have been made, the connections shall be subjected to an additional thermograph test and rechecked to confirm the problem has been corrected.
   3. The following components and connections shall be included in the thermograph testing:
      a. Service entrance
      b. Switchboards
      c. Switchboard main and feeder devices
      d. Feeder taps
      e. Busway cable terminations
      f. Busway joints
      g. Bustaps and busplug connections
      h. Emergency distribution system
      i. UPS system
      j. Motor control centers
      k. Distribution panels
      l. Panelboards
      m. Mechanical equipment connections (over 100 amps)
      n. Transformers

END OF SECTION 26 24 00
PART 1 - GENERAL

1.01 SUMMARY

A. Provide all devices specified herein, as indicated on the Drawings and as required to provide complete and operating systems.

B. The wiring devices shall be designed, manufactured and tested in accordance with the latest version of the following standards:
   1. NEMA WD-1
   2. NEMA WD-5
   3. Underwriters Laboratories
   4. NEC

PART 2 - PRODUCTS

2.01 GENERAL

A. The color of all devices, wall plates and coverplates shall be as selected by the Architect.
B. Refer to Marriott standards for additional device requirements.

2.02 SWITCHES

A. Wall switches, unless noted otherwise, shall be flush mounted, commercial grade 120/277 volt, 20 amp, toggle switches: (Typical for back of House and Common Areas - See AC Marriott Standards for additional requirements and specifications for all guest rooms and specialty areas).
   1. Single Pole: Leviton No. 1221 Series or equal by Hubbell, P&S or Cooper
   2. Double Pole: Leviton No. 1222 Series or equal by Hubbell, P&S or Cooper
   3. 3-way: Leviton No. 1223 Series or equal by Hubbell, P&S or Cooper
   4. 4-way: Leviton No. 1224 Series or equal by Hubbell, P&S or Cooper

B. Dimmer switches, unless specified otherwise in the Drawings or by the Architect, shall be Lutron Nova T-star series with wattage and type as required by the load and color/finish as selected by the Architect. Provide 3-way and 4-way dimmers where multiple dimmers as shown to control the same lights. Where on/off switches are indicated adjacent to dimmer switches they shall be ganged together and the on/off switches shall also be Lutron Nova T-star series to match the look of the dimmer switches.

C. Motor rated switches and switches indicated as pilot switches, unless noted otherwise, shall be flush mounted industrial grade, red pilot light “on” with overload protection as follows (note: wire per manufacturers recommendation):
   a. 120V, 20 amp Circuits – Hubbell HBL1221PL
   b. 120V, 30 amp Circuits – Hubbell HBL3031PL

D. Key switches, unless noted otherwise, shall be flush mounted, commercial grade, 120/277V, 20 amp:
   1. Single Pole: Leviton No. 1221-2L Series or equal by Hubbell, P&S or Cooper
   2. Double Pole: Leviton No. 1222-2L Series or equal by Hubbell, P&S or Cooper
   3. 3-Way: Leviton No. 1223-2L Series or equal by Hubbell, P&S or Cooper
   4. 4-Way: Leviton No. 1224-2L Series or equal by Hubbell, P&S or Cooper
E. Wall switches in back of house areas, unless noted otherwise, shall be commercial grade 120/277 volt, 20 amp, toggle switch Leviton No. 1221 Series or equal by Hubbell, P&S or Cooper.

F. Timer switches, unless noted otherwise, shall be digital time switch 24VAC or 120/277VAC as required. Timeout adjustments from 5 minutes to 12 hours. Set timer in the field to 4 hours for equipment rooms and 30 minutes for all other areas. For timer setting greater than 2 hours select the visual flash option and audible sound option. Color shall match that selected for the switches unless noted otherwise.

G. Wall mounted motion sensors, unless noted otherwise, shall be Wattstopper WS-250 for wall mounted at switch height and Wattstopper CI-200 for ceiling mounted. Provide power packs, relays, etc. as required to provide a complete system in each area. Color as selected by Architect. Adjust interval to 15 minutes at project completion unless noted otherwise. (Coordinate sensor type with lighting ballasts and provide accessories as required). Approved equal by Leviton or Cooper.

2.03 RECEPTACLES

A. Receptacles shall be plastic, 2P, 3W, grounded as follows, unless otherwise noted in contract documents: (Typical for back of House and Common Areas - See AC Marriott Standards for additional requirements and specifications for all guest rooms and specialty areas).
1. Duplex receptacles - for multi-outlet circuits, 125 volt, 15 amp rating Leviton 5262 Series or equal by Hubbell, P&S or Cooper.
2. Duplex receptacles - for dedicated, single-outlet circuits, 125 volt, 20 amp rating Leviton 5362 series or equal by Hubbell, P&S or Cooper.
3. Duplex isolated ground receptacle -125 volt, 20 amp rating Leviton 5362-IG series (provide color alternate of color for standard receptacles as selected by Architect) or equal by Hubbell, P&S or Cooper.
4. Simplex (single) receptacles -125 volt, 20 amp rating Leviton 5361 series or equal by Hubbell, P&S or Cooper.

B. Ground Fault Interrupter Receptacles (GFCI) shall be plastic, 2P, 3W, 125 volt, 20 amp, self protecting type Leviton 7899 series or equal by Hubbell, P&S or Cooper. Hospital GFCI receptacles shall be Leviton 7898-HG or equal by Hubbell, P&S or Cooper.

D. Weather receptacles shall have a duplex GFCI receptacle as specified above with a gasketed extra-duty in-use weatherproof coverplate T&B CKLSVU or approved equal by P&S, Leviton or Hubbell.

E. Hospital Grade receptacles shall be Leviton 8300 (duplex) and Leviton T7899 (GFCI) as applicable. Approved equals by Hubbell, P&S or Cooper.

2.04 COVERPLATES

A. Refer to Marriott standards for cover plate requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide appropriate outlet box for each device or multi-ganged devices.

B. Provide plaster ring reducer for boxes larger than the device plate.
C. Provide dimmer switch type and size to match load.

D. Coordinate locations of all devices with the Architect and the interior detail Drawings.

E. Coordinate cutting; obtain pre-cut openings from manufacturer for door switches, metal partitions and furniture mounted devices.

F. In general, devices in finished spaces shall be flush mounted. Verify the requirements of all spaces with the Architect.

G. Each device shall have a coverplate as is appropriate for the application. Coverplates shall be installed true and plumb with building lines, mortar joints and architectural features.

H. Mount receptacles and special systems outlets vertical and 18” above the finished floor to the device centerline, unless noted or required otherwise.

I. Mount switches vertical and 48” above the finished floor to the device centerline and 6” from a door strike, unless noted or required otherwise.

J. All exterior devices shall be provided with a weatherproof cover/enclosure. Exterior receptacles shall be GFCI type.

K. Coordinate mounting heights for devices indicated to be mounted over counter with the Architect.

L. Provide a green insulated bonding jumper for all grounded devices and bond to the outlet box.

M. Each outlet used as a junction box, or for future device or fixture, shall be fitted with a blank coverplate to match other device coverplates.

N. Floor outlets shall be of the necessary type suitable for the application and installed per the manufacturers recommendation. Fire ratings shall be maintained. Where the installation of a specified or required floor box effects the elevated slab/floor fire rating, the necessary fire assembly (approved by the Architect) shall be constructed below the slab.

O. Do not locate junction boxes or voice/data conduit stub downs for poke-thru devices above a non-accessible ceiling. In these cases extend the poke-thru conduit to an accessible ceiling.

END OF SECTION 26 27 00
PART 1 - GENERAL

1.01 SUMMARY

A. Provide all equipment, materials, tools and labor to provide a complete system for motor operation. Refer to other related Sections of Divisions 21, 22 and 23 and the Mechanical, Electrical and Plumbing Drawings.

B. A Motor starter shall be provided by Division 26 for each motor except for those specified in Divisions 21, 22 or 23 to be furnished by that Division. All motor starters not integral to the equipment served shall be installed and connected by Division 26.

C. All low voltage control wiring shall be provided by Division 21, 22 or 23 unless specifically noted otherwise on the Drawings.

D. Provide 120 volt line voltage for controls as required. Provide 120 volt to all line voltage motor operated dampers. Provide fire alarm connections to all fire and smoke dampers. Coordinate with Divisions 21, 22 and 23.

PART 2 - PRODUCTS

2.01 MOTOR STARTERS

A. All motor starters shall be UL listed.

B. The motor starters shall be front wired with all terminals accessible for wiring directly from the front. All contacts shall be solid silver cadmium oxide alloy. Bare copper or silver-flashed type shall not be permitted. Operating coils shall be pressure molded and so designed that if accidentally connected to excessive voltage they will not expand, bubble, or melt. When a coil fails under over-voltage conditions, the motor controller shall definitely drop out and not freeze the contacts in the “ON” position.

C. All three-phase full voltage magnetic motor starters shall have overload protection in all three phases. All single phase full voltage magnetic motor controllers shall have overload protection in ungrounded phases. All two-speed full voltage magnetic motor controllers shall have overload protection in all six (6) legs of the controller. Overload relays shall be furnished for each phase and shall be of the hand-reset trip-free variety so that blocking the reset mechanism in the reset position will not prevent the motor controller from dropping out if the motor is overloaded. This specifically excludes those overload relays which change to automatic reset from hand-reset when the reset mechanism is blocked. Accidentally depressing the reset button or mechanism will not shut-off the motor. Overload relays shall NOT be field convertible from hand to automatic reset type. Overload relays shall be the thermal bi-metallic type. Circuit breaker disconnects for combination motor starters shall be magnetic only.

D. Motor starters shall be provided with auxiliary dry contacts as follows:
   1. NEMA size 3 and larger: two (2) N.O. and two (2) N.C.
   2. NEMA size 2: two (2) N.O. and one (1) N.C.
   3. NEMA size 1 and 0: one (1) N.O. and one (1) N.C.
E. Provide necessary terminal strips and relays as required for interface with the motor operation, the Building Automation System, Fire Alarm System, and Fireman’s Override Panel (if applicable). Coordinate with Division 23.

F. In general, motor starter enclosures shall be NEMA Type 1, general purpose unless exposed to the weather or unless otherwise specified on the Drawings. Motor starters exposed to the weather shall be NEMA Type 3R watertight.

G. Generally, holding coils in full voltage magnetic motor starters shall be suitable for use on 120 volt, AC control voltage. Each controller shall have a control power transformer with primary and secondary fuses. Control power transformer shall have at least 50 VA capacity over and above the standard capacity required for holding coil and LED pilot light duty. Sizing of control transformers shall be coordinated with Division 23.

H. Two-speed motor starters for two-speed motors shall have “decelerating relay” between high and low speed.

I. Each motor starter shall be equipped with a handoff-automatic or start-stop push-button, as required by Division 15. Provide green LED light for “RUNNING”, red LED light for “STOPPED”. Provide amber LED light reading “TRIPPED” and interfaced with overload relay alarm contacts. Two-speed motor starters shall have “fast-slow” LED lights as well as a fast-slow selector switch in conjunction with the HOA as required by Division 23. LED lights will be operated by an interlock in the motor starters not placed across the operating coil. In addition to the holding interlock and LED light interlocks, each starter shall have four extra interlock contacts – two normally open and two normally closed.

J. Where indicated on the Drawings at individual motor starters, provide surge protection on the load side of the motor controller. Surge protection shall consist of one protective capacitor and one secondary arrestor.


PART 3 - EXECUTION

3.01 INSTALLATION

A. All motor starters shall be installed by Division 26 unless an integral part of a piece of equipment.

B. Provide all power wiring to motors unless pre-wired as part of a packaged unit.

C. Provide line voltage power wiring through a control device (i.e. fire stats, thermostat, aqua stat, smoke dampers) where required. Provide duct smoke detectors or in-duct smoke detectors at all smoke dampers. Coordinate with Divisions 21, 22 and 23.

D. Where multiple mechanical terminal units (e.g. PIU’s) containing multi-phase heating elements and single phase motors are connected together on the same multi-phase homerun/circuit, the single-phase motors shall be connected to alternate phases to balance the load. Coordinate with Division 23. Provide a neutral conductor of equal size to the phase conductors unless noted otherwise on the Drawings.

END OF SECTION 26 29 00
PART 1 - GENERAL

1.01 SUMMARY

A. Provide all labor and material necessary to install a standby diesel engine generator set in accordance with the contract documents and manufacturer’s drawings and installation instructions in a complete and operating condition.

B. The engine – generator set shall be suitable for outdoor use and complete with weather-protective enclosure and components as identified in this specification.

1.02 SUBMITTALS

A. Furnish a comprehensive component list and manufacturer produced data sheets showing the following information:
   1. Technical Data - Manufacturer produced generator set specification or data sheets identifying make and model of engine and generator, and including relevant component design and performance data.
   2. Engine:
      a. Make and model of engine and generator
      b. Type, aspiration, compression ratio, and combustion cycle
      c. Bore, stroke, displacement, and number of cylinders
      d. Engine lubricating oil capacity
      e. Engine coolant capacity without radiator
      f. Engine coolant capacity with radiator
      g. Coolant pump external resistance (maximum)
      h. Coolant pump flow at maximum resistance
   3. Alternator:
      a. Model
      b. Frame
      c. Insulation class
      d. Number of leads
      e. Weight, total
      f. Weight, rotor
      g. Air flow
   4. Technical Data at rated voltage:
      a. Efficiency at 0.8 power factor for: 50%, 75%, 100% load
      b. Time constants, short circuit transient (T'D)
      c. Time constants, armature short circuit (TA)
      d. Reactance, subtransient - direct axis (X*D),
      e. Reactance, transient - saturated (X'D)
      f. Reactance, synchronous - direct axis (XD)
      g. Reactance, negative sequence (X2)
      h. Reactance, zero sequence (X0)
      i. Fault current, 3 phase symmetrical
      j. Decrement curve
   5. Radiator:
      a. Model
      b. Type
      c. Fan drive ratio
      d. Coolant capacity, radiator
      e. Coolant capacity, radiator and engine
      f. Weight: dry & wet
   Weight: dry & wet  
7. Performance - Based on SAE J1349 standard conditions of 100kPa (29.61 in hg) and  
   25C (77F); also at conditions of ISO 3046/1, DIN 6271 and BS 5514. Fuel rates are  
   based on ISO 3046 and on fuel oil of 35 degrees API (16C or 60F) gravity having a  
   LHV of 42780 kJ/kg (18,390 Btu/lb) when used at 29C (85F) and weighing 838.9 g/l  
   (7.001 lbs/U.S. gal). Performance of the genset shall also meet the design site  
   conditions.  
8. Auxiliary Equipment – Specification and data sheets, including switchgear, transfer  
   switch, vibration isolators, enclosure, muffler, battery charger, batteries, cooling  
   system and fuel tank.  
9. Drawings - General dimensions drawings showing overall generator set  
   measurements, mounting location, and interconnect points for load leads, fuel,  
   exhaust, cooling and drain lines.  
10. Wiring - Wiring diagrams, schematics and control panel outline drawings published  
    by the manufacturer in Joint Industrial Council (JIC) format for controls and  
    switchgear showing interconnected points and logic diagrams for use by contractor  
    and owner.  
11. Warranty Statements - Warranty verification published by the manufacturer.  

1.03 SYSTEM DESCRIPTION  

A. The electric power generating system shall have a site capability of that shown on the  
   drawings. This power shall be applied for Standby operation.  

B. The system shall consist of generator set(s) which include all controls, protection, wiring,  
   and accessories for automatic start-stop operation. After starting, the unit(s) will attain  
   rated speed and voltage, and accept rated load. Generator set speed shall be controlled  
   by the engine governor, while generator output voltage regulation shall be a function of  
   the generator automatic voltage regulator. Manual adjustment of generator speed and  
   voltage shall be provided.  

C. The set shall immediately shut down in the event of overspeed, low oil pressure, high  
   water temperature and overcrank. Cause of shutdown shall be indicated by a light  
   annunciator. System logic shall prevent restart until fault is cleared. There shall also be a  
   provision for manual shutdown.  

1.04 SYSTEM PERFORMANCE  

A. The generator output kW shall be as identified in this specification and shall take into  
   consideration all generator mounted parasitic and external loads such as radiator fans.  

B. The kW rating shall be for continuous electrical service during interruption of the normal  
   utility source and shall be certified by the manufacturer for the actual shipped unit. The  
   output rating shall be capable of the design conditions identified in this specification. The  
   genset shall also meet the following minimum industry standards: ISO 3046; BS 5514,  
   DIN 6271, SAE J1349 and API 7B-11C.  

C. Diesel engines shall be able to deliver rated power at design ambient when operating on  
   No. 2 diesel fuel having 35 degree API (16C, 60F) specific gravity. Fuel rates shall be  
   based on a low heating value of 42,780 kJ/kg (18,390 Btu/lb) when used at 29C (85F)  
   and weighing 838.9 g/l (7.001 lbs/U.S. gal).  

D. Generators shall start, achieve rated voltage and frequency, and be capable of accepting  
   load within 10 seconds when properly equipped and maintained.  

E. The generator set shall be capable of accepting a 100% block load as applied in a single  
   step and shall be able to recover to a steady state condition within the timeframe
identified in the following paragraph. Generator transient response performance shall conform to ISO 8528. No other definition of transient response shall be accepted.

F. The maximum voltage dip shall be no greater than that identified in the following paragraph. The voltage dip shall be identified as that recorded by a light beam oscilloscope and strip chart recorder. No other definition of voltage dip shall be accepted.

G. The power generating system shall satisfy the following performance criteria at site conditions:

<table>
<thead>
<tr>
<th>Specification</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total of Power Capability</td>
<td>as shown</td>
</tr>
<tr>
<td>Frequency</td>
<td>60 Hz</td>
</tr>
<tr>
<td>3 Phase Volts</td>
<td>as shown</td>
</tr>
<tr>
<td>Allowable Voltage Dip</td>
<td>25%</td>
</tr>
<tr>
<td>Average Power Factor</td>
<td>0.8</td>
</tr>
<tr>
<td>Altitude</td>
<td>per site location</td>
</tr>
<tr>
<td>Design Ambient Temperature</td>
<td>110 F</td>
</tr>
<tr>
<td>Fuel Type</td>
<td>Diesel</td>
</tr>
<tr>
<td>Total air restriction</td>
<td>0.75” (for use with enclosures)</td>
</tr>
</tbody>
</table>

The bidding manufacturer is required to provide a product that meets the designed power capability at the design ambient and air restrictions. If the manufacturer’s product and output rating is not based on the above ambient conditions, than they are responsible for providing a product that is capable for producing the specified rating at the design conditions. Any de-rating requirements must be clearly identified on page one of the Bidder’s bill of materials.

1.05 EQUIPMENT ALTERNATIVES

A. In additional to submittal requirements contained in other parts of this specification, data for substitute equipment shall be made a minimum of ten (10) days prior to bid date and include the following:
   1. Plan Drawing - Verification that substitute equipment will fit into the space allocated and allow for removal and service.
   2. Air Flow Requirements - Provision for combustion, ventilating, and radiator cooling air.
   3. Product Rating conditions and any required de-rating for operating conditions other than design conditions noted in this specification shall be clearly noted and highlighted by the bidder.
   4. Connections - Wiring and piping diagrams describing interconnect changes.
   5. Load Study - Complete load review to confirm that generating equipment operates satisfactory and complies to original specification during all phases of operation, including motor starting and transient loading capabilities.
   6. Specifications - Specification sheets and support literature to show that alternate equipment is in compliance with all specifications.
   7. Certification - List of projects using similar equipment operating under similar design conditions for the last five years. Copies of certified site test reports shall also be provided with ambient conditions listed on the reports.
   8. Exceptions - All deviations from these specifications shall be clearly highlighted and noted in the bill of materials.

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. The equipment shall be as manufactured by Caterpillar, Kohler, Generac or Cummins provided the product being offered meets this specification as defined within the content.
B. All components shall have been designed to achieve optimum physical and performance compatibility and prototype tested to prove integrated design capability. The complete system shall have been factory fabricated, assembled and production tested by the manufacturer.

C. Special ratings and non-standard consists will not be accepted. Published specification sheets must be produced for the product being offered. The manufacturer shall have the product being offered installed in a minimum of 20 sites.

D. Prototype and production testing must be performed for the specific rating and consist being offered and certified test reports shall be provided.

2.02 ENGINE

A. The engine shall be water cooled, in-line or vee-type, four stroke compression ignition diesel. It shall meet specifications when operation on number 2 diesel fuel. Diesel engines requiring premium fuels will not be considered. The engine shall be equipped with air filters, fuel filters, oil filters, fuel pressure gauge, lube oil, lube oil cooler, fuel transfer pump, 50/50 glycol mixture, pressure gauge, water pump, water temperature gauge, service hour meter, flywheel, and flywheel housing.

B. The engine block shall be of one piece design and cast of high tensile strength iron in the system manufacturer's own foundry. The crankshaft shall be a one piece forging with regrind able wear surfaces hardened through heat treat methods. The cylinder wear surfaces shall be induction hardened over their entire length. Main and rod bearings shall consist of aluminum bonded by copper to a steel backing.

2.03 LUBRICATION SYSTEM

A. The lubrication oil pump shall be a positive displacement type that is integral with the engine and gear driven from the engine gear train. The system shall incorporate full flow filtration with bypass valve to continue lubrication in the event of filter clogging. The bypass valve must be integral with the engine filter base or receptacle. The oil filter shall incorporate a self-lubricating, free rotating seal and have a nonmetallic core sufficiently rigid to minimize movement or shifting of the filtration media.

2.04 DIESEL FUEL SYSTEM

A. The engine fuel system shall consist of a fuel filter, engine mounted fuel transfer pump, injection pumps, lines, and nozzles. The fuel transfer pump, injection pumps, rack and pinion assembly, and timing mechanism shall be maintenance and adjustment free for the life of the equipment. The fuel filter shall not require changing more frequently than once per year or every 250 hours, whichever comes first.

B. The engine transfer pump shall deliver fuel under low pressure to individual injection pumps - one for each cylinder. External, high pressure (greater than 5,000 psi) fuel systems will not be accepted.

C. Racor brand fuel/water separator shall protect the fuel system from water damage. A manual fuel priming pump shall facilitate priming and bleeding air from the system. Flexible fuel lines between engine and fuel supply shall be installed to isolate vibration.

D. A primary fuel filter shall also be provided to protect the fuel transfer pump from impurities and debris in the fuel system.

2.05 FUEL STORAGE SYSTEM
A. Sub-base Fuel Tank - UL142 listed, double wall, sub-base fuel tank shall be provided with the generator set. The tank shall have a low level alarm, critical low shutoff, high level alarm, leak detection and shall have flexible supply and return line connections. The sub-base fuel tank shall be furnished with a stub up area for mechanical and electrical connections. Steel cross members shall support genset and add rigidity to the base with vibration isolators install between the generator set and supports.

B. Fuel Tank shall be sized to accommodate generator running at 100% full load for a minimum of eight (8) hours. Coordinate fuel tank size with generator manufacturer.

2.06 GOVERNOR

A. The engine governor shall control engine speed and transient load response within commercial and ISO 8528 tolerances. It will be selected, installed, and tested by the generator set manufacturer.

B. The engine governor shall be a minimum quality of a Caterpillar ADEM or Woodward 2301 Governor. Speed droop shall be externally adjustable from 0 (isochronous) to 10% from no load to full rated load. Steady state frequency regulation shall be +/- 0.25 percent. Speed shall be sensed by a magnetic pickup off the engine flywheel ring gear. A provision for remote speed adjustment shall be included. In the event of a DC power loss, the forward acting actuator will move to the minimum fuel position.

2.07 COOLING SYSTEM

A. A radiator with blower fan shall be provided to maintain safe operation at the specified ambient temperature. Air flow restriction through the radiator shall not exceed 0.5" H2O. Provide ductwork with flexible connection between radiator and discharge louver frame.

B. A radiator with blower fan shall be provided to maintain safe operation at the specified ambient temperature. Air flow restriction through the radiator shall not exceed 0.5" H2O. Provide ductwork with flexible connection between radiator and discharge louver frame.

C. The radiator shall be sized to cool the engine continuously while operating at full rated load and at site conditions based on a site air flow restriction of 0.5” and a minimum ambient temperature of 110-degrees F. Any required additional de-rations of the radiator resulting from placing the genset inside a standard enclosure, sound attenuated enclosure or inside a building, shall be taken into consideration by the system supplier.

D. The radiator shall be supplied with a 50/50 glycol mixture.

E. Provide an engine jacket water heater with thermostat to maintain coolant temperature at not lower than 90 degrees F. Manual shutoff valves shall be incorporated to isolate the jacket water heater during servicing.

2.08 INLET AIR SYSTEM

A. The engine air cleaner shall be engine mounted with dry element requiring replacement no more frequently than 250 operating hours or once each year. If external ducting is required, maximum restriction to the combustion air inlet shall be 27 in H2O with air flow of 932 cfm. Design inlet air restriction shall be based on 0.75” H2O for use with an enclosure or 0.50” for use inside a building.

2.09 EXHAUST SYSTEM

A. Outdoor Exhaust System – A critical grade exhaust silencer, companion flanges and flexible stainless steel exhaust fittings shall be provided according to the manufacturer’s recommendations. The silencer shall be mounted so that its weight is not supported by
the engine. Exhaust pipe size shall be sufficient to ensure that exhaust back-pressure does not exceed the maximum limitations specified by the engine manufacturer. For non-sound attenuated enclosures, the muffler shall be designed for mounting on top of the enclosure. For sound attenuated enclosures, the muffler shall be designed for mounting inside the enclosure and the manufacturer shall provide insulation for the muffler and flexible connection.

2.10 WIRING AND CONDUIT

A. Engine and generator control wiring shall be multi-strand annealed copper conductors encased by cross-linked polyethylene insulation resistant to heat, abrasion, oil, water, antifreeze, and diesel fuel. Wiring shall be suitable for continuous use at 120°C (250°F) with insulation not brittle at -50°C (-60°F). Cables shall be enclosed in nylon flexible conduit which is slotted to allow easy access and moisture to escape. Reusable bulkhead fittings will attach the conduit to generator set mounted junction boxes.

2.11 ELECTRICAL STARTING SYSTEMS

A. The engine starting system shall include 24 volt DC starting motor(s), starter relay, and automatic reset circuit breaker to protect against butt engagement.

B. A belt driven battery charging alternator shall be provided with transistorized voltage regulator. Voltage shall match the electric starting system.

C. Batteries shall be maintenance free, lead acid type mounted near the starting motor and supplied with a corrosion resistant battery rack. Required cables will be furnished and sized to satisfy circuit requirements. The system shall be capable of starting a properly equipped engine within 10 seconds at ambient temperatures greater than –10 Degrees F. For gensets above 1000kW, the batteries shall have a 2600 CCA, 380 AH rating and shall be rated for operation in ambient temperatures of –10-degrees F.

D. For generators rated 800kW and below, 10 ampere, dual rate, constant voltage charger shall be provided. For generators over 800kW, a 20 ampere dual rate, constant voltage, battery charger shall be provided. The charger shall accept 120 - 208 - 240 volt AC single phase input to provide 24 volt DC output. It shall be fused on the AC input and DC output, and incorporate current limiting circuitry to avoid the need for a crank disconnect relay. An AC voltage power switch shall be mounted on the face of the charger and shielded from accidental switching. The charger shall include an AC ammeter and voltmeter, a failure malfunction alarm switch, and be housed in a NEMA 1 enclosure suitable for wall mounting.

2.12 GENERATOR

A. The generator shall be close coupled, drip proof and guarded, constructed to NEMA 1 and IP 22 standards, single bearing, salient pole, revolving field, synchronous type with amortisseur windings in the pole faces of the rotating field.

B. The generator shall in inherently capable of parallel operation with other power sources of equivalent electrical characteristics.

C. The generator shall be brushless, permanent magnet, and shall be capable of withstanding a three phase plaid of 300% rated current for 10 seconds, and sustaining 150% of continuous load current for 2 minutes with field set for normal rated load excitation. It shall exhibit less than 5% waveform deviation at no load.

D. The generator terminal box shall provide generous space for entrance and installation of power cables.
E. Generator shall be equipped with an AC single phase space heater to minimize condensation while the generator set is idle. The heaters shall be capable of easily mounting in the assembled alternator.

2.13 VOLTAGE REGULATOR

A. The automatic voltage regulator shall maintain alternator output voltage by controlling the current applied to the exciter field of the alternator.

B. The regulator shall be a solid state design which includes electronic voltage buildup and overcurrent protection. The voltage regulator shall be equivalent to either a Caterpillar VR3 or DVR. It shall incorporate 1:1 volts per Hertz characteristics with the regulated voltage a linear function proportional to frequency over a 30 to 70 Hz range.

C. The regulator shall be suitable for mounting within or external to the alternator assembly, and have provision for remote voltage level control, using 16 ga shielded wire.

D. As installed, the voltage regulator shall meet the applicable sections of the Canadian Standards Association (CSA), International Electrotechnical Commission (IEC), Institute of Electrical and Electronic Engineers (IEEE), National Electrical Manufacturers Association (NEMA).

2.14 MOUNTING

A. The engine and generator shall be assembled to a common base by the engine-generator manufacturer. The generator set base shall be designed and built by the engine-generator manufacturer to resist deflection, maintain alignment, and minimize resonant linear vibration.

B. The generator set shall be mounted to the sub-base fuel tank with spring type vibration isolators between the generator rails and sub-base fuel tank. Flexible fuel lines shall be connected from the sub-base fuel tank to the generator fuel supply and return connections.

2.15 WEATHERPROOF ENCLOSURE WITH SOUND PROOFING

A. The package generators set shall be supplied with a weatherproof enclosure integrally mounted to the sub-base fuel tank. The enclosure shall be constructed to allow full access to the engine for maintenance without exposing personnel to any moving machinery and shall have two personnel doors.

B. Exhaust muffler shall be mounted on top of the enclosure with mounting brackets and designed with a flexible exhaust fitting that prevents the weight of the muffler is not supported by the engine.

C. Enclosure shall have oil drain, coolant drain and crankcase breather lines extended to exterior of enclosure.

D. Enclosure shall be provided with critical silencer on the exhaust system with a fully lined enclosure with sound deadening material to reduce sound level.

2.16 AUTOMATIC LOAD TRANSFER SWITCHES

A. The amperage rating of the automatic load transfer switch shall be as shown. Each transfer switch shall be 4-pole or 3-pole with cross-over neutral. Manufacturer shall be ASCO, Russell or Zenith.
B. The automatic transfer switch shall be mechanically held on both the emergency and the normal side. The switch shall be double throw with the main contacts rigidly and mechanically interlocked to insure only two possible positions: Normal or Emergency. A manual operator must be provided to enable manual operation without having to assemble the handle.

C. The automatic load transfer control shall be open transition and rated for continuous duty when enclosed in a non-ventilated NEMA 1 enclosure. It shall be rated for all classes of load, including inductive and non-inductive, at 600 volts and tungsten lamp load at 250 volts. The transfer switch portion of the control shall be designed, built and tested to close on an inrush current up to and including twenty (20) times the continuous rating of the switch without welding or excessive burning of the contacts. The transfer switch shall be capable of enduring six thousand (6000) cycles of operation, at rated current, at a rate of six (6) cycles per minute, without failure. One cycle shall consist of one complete opening and closure of both sets of contacts on an inrush current of ten (10) times the continuous rating of the switch.

D. The transfer switch shall be as listed under U.L. 1008. Switch utilizing reversing contactor mechanisms as a means to transfer load are disallowed and will not be considered.

E. The automatic load transfer switch shall include the following accessories:
   1. Engine starting contacts to provide for generator starting.
   2. Full phase protection. Three-phase relays shall be field adjustable, close differential type with 92-95% pickup and 82-85% drop out. Relays are to be connected across live lines.
   3. Test switch, to simulate a power outage.
   4. Adjustable time delay on engine starting to override momentary outages and nuisance voltage dips.
   5. Adjustable time delay on transfer of load to emergency source. Adjustable time delay to open transfer switch contact to allow motor loads to decay.
   6. Adjustable time delay on retransfer of load to normal with 5 minute cool-down timer wherein the generator set runs unloaded after transfer to line.
   7. Plant exerciser to start and run the generator set with or without load each 168 hours for a 30 minute interval. Selector switch will be provided for with-load or without-load testing.
   8. Two auxiliary contacts closed on emergency and two auxiliary contact open on emergency.
   9. Pilot lights to indicate the normal and emergency position of the transfer switch.
  10. Isolated (un-grounded) neutral bar.
  11. Disconnect plug.

2.17 CONTROLS, PROTECTION & MONITORING

A. The controls, protection, and monitoring systems of the generator set and its operation shall be the responsibility of the generator set manufacturer. All subsystem components, interfaces, and logic shall be compatible with engine mounted devices.

B. The control panel shall be shock mounted on the generator and have the capability to face either side or the rear of the generator and shall control, protect, meter and annunci ate all functions necessary to confirm the operational status of the generator set.

C. The control panel shall be sealed in a dust tight and watertight module with sealed wire entries into the enclosure so as to protect the circuitry and internal components from oil, soot, fumes, diesel fuel, dirt, moisture and debris. The panel module shall comply with NEMA 4 for environmental protection, while the total panel shall qualify for IEC 144 and NEMA 12.
D. The 24 volt DC system shall incorporate energize to run logic and include:

Control:

Alternator voltage level rheostat and ammeter/voltmeter phase selector switch shall be mounted on the panel door.

The engine start-stop switch shall be door mounted and include positions for off/reset, run, start and automatic mode. Start-stop logic shall have provisions for cycle cranking programmable from 5-60 second cycles, for total crank time of 5-120 seconds. Cooldown operation shall be programmable from 0-30 minutes with a signal to allow removal of the load from the generator set during cooldown.

Shutdowns/Annunciation:

The generator set shall shut down and red flashing LEDs shall signal operational faults of overcrank, overspeed, high water temperature, and low oil pressure. High water temperature, low coolant level, and low oil pressure shall be programmable for shutdown or alarm. A minimum of three (3) spare fault inputs shall be available which can be programmed for alarm or shutdown, with 0-250 second time delay. There shall be a lamp test switchpad accessible from the front of the panel.

Monitor:

Monitoring devices shall include AC voltmeter, AC ammeter, ammeter/voltmeter phase select switch, frequency meter, electric hour-meter, oil pressure, water temperature, engine RPM, battery DC volts, oil pressure, and jacket water temperature.

Safety Devices:

ISO red emergency stop pushbutton shall be provided, and all controls, annunciation, and monitors labeled with ISO symbols.

Protection:

A lockable door shall be included which is bottom hinged to allow full panel exposure when open.

E. A cycle crank timer shall provide five 10 second cranking periods separated by 10 second rest periods. A cool down timer shall provide an adjustable 0-30 minute engine running period before shutdown after removal of load.

2.18 ALARM - NFPA 99

A. NFPA-99 requirements for local annunciation shall be satisfied by a solid state panel which includes a common red indicating light and silencable alarm horn to annunciate all alarms and shutdowns provided by the generator set control panel when equipped with the NFPA-99 alarm module.

2.19 REMOTE ANNUNCIATOR PANEL - NFPA 110

A. NFPA-110 requirements for remote annunciation shall be satisfied by a remote mounted solid state panel which includes a common red indicating light and silencable alarm horn to annunciate all alarms and shutdowns provided by the generator set control panel when equipped with the NFPA-110 alarm module. The remote annunciator shall have a minimum of 16 lights.

B. Locate the annunciator panel as directed by the Owner.
2.20 GENERATOR MAIN CIRCUIT BREAKER

A. The generator main circuit breaker(s) shall be mounted inside the weatherproof enclosure and on the generator in a termination box. The main breaker and distribution breakers shall be sized according to the drawings.

B. The circuit breaker shall be sized such that the generator will be capable of producing the 100% rated kW of the genset at a 0.8 power factor for a minimum of 4 hours. If a molded case breaker is provided, the breaker shall be have a breaker frame size with a minimum of 120% of the full load amperage of the generator. If an insulated case breaker is provided, the breaker can be sized for 100% of the full load amperage of the generator.

PART 3 - EXECUTION

3.01 EXECUTION

A. The following articles and paragraphs are intended to define acceptable procedures and practices of manufacturing, inspecting, installing, and testing the generator set and associated equipment.

B. The genset shall be subjected to a full load, resistive load test prior to shipment to the jobsite. The tests shall demonstrate at a minimum the full rated load capability of the genset, voltage, amperage, fuel consumption shall be recorded.

3.02 SHIPMENT TO JOBSITE

A. Delivery shall be FOB to the jobsite by the system manufacturer's authorized dealer.

3.03 INSTALLATION

A. The installation shall be performed in accordance with shop drawings, specifications, and the manufacturer's instructions.

3.04 FIELD QUALITY CONTROL

A. The system supplier shall perform a pre-startup inspection. The complete installation shall be checked for procedural and operational compliance and any deficiencies shall be noted and corrected by the Contractor.

3.05 POST INSTALLATION TESTING

A. Following installation, the following tests shall be performed by the system supplier in the presence of the owner's engineer or designated appointee:

PRESTART CHECKS:
- oil level
- water level
- day tank fuel level
- battery connection and charge condition
- air start supply pressure (if so equipped)
- engine to control interconnects
- engine generator intake/exhaust obstructions
- engine room ventilation obstructions
- removal of all packing materials

OPERATION:
Load - 1-hours operation at 50% of full load rating. 1 hours at 75% full load rating. 1-
hours operation at 100% of full load rating. 0 to 100% step load, 0 to 50% step load, 0 to 75% step load and 15 minute intervals. The following shall be recorded at fifteen minute intervals:

- Voltage and amperage (3 phase), frequency
- Fuel pressure, oil pressure and water temperature
- Exhaust gas temperature at engine exhaust outlet
- Ambient temperature

Upon successful completion of the above test, the generator set shall be subjected to a 100% block load test and the recovery timeframe to steady state recorded. This test shall be repeated a total of 4 times.

Proper operation of controls, engine shutdown, and safety devices shall be demonstrated and all testing requirements of NFPA 110 shall be met. A resistive type load bank shall be used for this testing and a test report shall be provided at the successful conclusion of the above test.

3.06 MINIMUM SERVICE AND WARRANTY QUALIFICATIONS

A. The manufacturer's warranty shall in no event be for a period of less than five (5) years from date of initial start-up of the system or 1500 operating hours, whichever comes first.

B. The warranty shall include repair parts, labor, reasonable travel expense necessary for repairs at the jobsite, and expendables (lubricating oil, filters, antifreeze, and other service items made unusable by the defect) used during the course of repair. Applicable deductible costs shall be specified in the manufacturer's warranty.

C. The system supplier shall provide factory trained servicemen and shall have sufficient parts inventory to maintain over the counter availability of at least 90% of any required parts and shall guarantee 100% parts availability within 48 hours from the time an order is entered with the dealer. Manufacturers who do not meet this qualification will be rejected in their entirety.

3.07 ORIENTATION

A. The system supplier shall provide a complete orientation for the owner's engineering and maintenance personnel. Orientation shall include both classroom and hands-on instruction. Topics covered shall include control operation, schematics, wiring diagrams, meters, indicators, warning lights, shutdown system and routine maintenance.

3.08 SERVICE MANUALS AND PARTS BOOKS

A. The system manufacturer's authorized local dealer shall furnish one copy each of the manuals and books listed below for each unit under this contract:

1. OPERATING INSTRUCTIONS - with description and illustration of all switchgear controls and indicators and engine and generator controls.
2. PARTS BOOKS - that illustrate and list all assemblies, subassemblies and components, except standard fastening hardware (nuts, bolts, washers, etc.).
3. PREVENTATIVE MAINTENANCE INSTRUCTIONS - on the complete system that cover daily, weekly, monthly, biannual, and annual maintenance requirements and include a complete lubrication chart.
4. ROUTINE TEST PROCEDURES - for all electronic and electrical circuits and for the main AC generator.
5. TROUBLESHOOTING CHART - covering the complete generator set showing description of trouble, probable cause, and suggested remedy.
6. RECOMMENDED SPARE PARTS LIST - showing all consumables anticipated to be required during routine maintenance and test.
7. WIRING DIAGRAMS AND SCHEMATICS - showing function of all electrical components

END OF SECTION 26 32 00
SECTION 26 32 00

EMERGENCY STANDBY GENERATOR – (NATURAL GAS)

PART 1 - GENERAL

1.01 SUMMARY

A. Natural Gas Generator shall be priced as an add alternate.
B. Provide all labor and material necessary to install a standby natural gas fueled engine generator set in accordance with the contract documents and manufacturer’s drawings and installation instructions in a complete and operating condition.
C. The CONTRACTOR shall be responsible for connecting all fuel piping and necessary auxiliary equipment (gas regulators, etc.) for a fully operational fuel system.
D. The engine – generator set shall be suitable for outdoor use and complete with weather-protective enclosure and components as identified in this specification.
E. A complete system load test shall be performed after all equipment is installed.

1.02 SUBMITTALS

A. Furnish a comprehensive component list and manufacturer produced data sheets showing the following information:
1. Technical Data - Manufacturer produced generator set specification or data sheets identifying make and model of engine and generator, and including relevant component design and performance data.
2. Engine:
   a. Make and model of engine and generator
   b. Type, aspiration, compression ratio, and combustion cycle
   c. Bore, stroke, displacement, and number of cylinders
   d. Engine lubricating oil capacity
   e. Engine coolant capacity without radiator
   f. Engine coolant capacity with radiator
   g. Coolant pump external resistance (maximum)
   h. Coolant pump flow at maximum resistance
3. Alternator:
   a. Model
   b. Frame
   c. Insulation class
   d. Number of leads
   e. Weight, total
   f. Weight, rotor
   g. Air flow
4. Technical Data at rated voltage:
   a. Efficiency at 0.8 power factor for: 50%, 75%, 100% load
   b. Time constants, short circuit transient (T'D)
   c. Time constants, armature short circuit (TA)
   d. Reactance, subtransient - direct axis (X*D),
   e. Reactance, transient - saturated (X'D)
   f. Reactance, synchronous - direct axis (XD)
   g. Reactance, negative sequence (X2)
   h. Reactance, zero sequence (X0)
   i. Fault current, 3 phase symmetrical
j.  Decrement curve
5.  Radiator:
   a.  Model
   b.  Type
   c.  Fan drive ratio
   d.  Coolant capacity, radiator
   e.  Coolant capacity, radiator and engine
   f.  Weight: dry & wet
    Weight: dry & wet
7.  Performance - Based on SAE J1349 standard conditions of 100kPa (29.61 in hg) and 25C (77F); also at conditions of ISO 3046/1, DIN 6271 and BS 5514. Fuel rates are based on ISO 3046 and on fuel oil of 35 degrees API (16C or 60F) gravity having a LHV of 42780 kJ/kg (18,390 Btu/lb) when used at 29C (85F) and weighing 838.9 g/l (7.001 lbs/U.S. gal).
    Performance of the genset shall also meet the design site conditions.
8.  Auxiliary Equipment – Specification and data sheets, including switchgear, transfer switch, vibration isolators, enclosure, muffler, battery charger, batteries, cooling system, fuel, piping, and fuel regulator.
9.  Drawings - General dimensions drawings showing overall generator set measurements, mounting location, and interconnect points for load leads, fuel, exhaust, cooling and drain lines.
10.  Wiring - Wiring diagrams, schematics and control panel outline drawings published by the manufacturer in Joint Industrial Council (JIC) format for controls and switchgear showing interconnected points and logic diagrams for use by contractor and owner.
11.  Warranty Statements - Warranty verification published by the manufacturer.
12.  Control Panel.

1.03  SYSTEM DESCRIPTION

A.  The electric power generating system shall have a site capability of that shown on the drawings. This power shall be applied for Standby operation.

B.  The system shall consist of generator set(s) which include all controls, protection, wiring, and accessories for automatic start-stop operation. After starting, the unit(s) will attain rated speed and voltage, and accept rated load. Generator set speed shall be controlled by the engine governor, while generator output voltage regulation shall be a function of the generator automatic voltage regulator. Manual adjustment of generator speed and voltage shall be provided.

C.  The set shall immediately shut down in the event of overspeed, low oil pressure, high water temperature and overcrank. Cause of shutdown shall be indicated by a light annunciator. System logic shall prevent restart until fault is cleared. There shall also be a provision for manual shutdown.

1.04  SYSTEM PERFORMANCE

A.  The generator output kw shall be as identified in this specification and shall take into consideration all generator mounted parasitic and external loads such as radiator fans.

B.  The kw rating shall be for continuous electrical service during interruption of the normal utility source and shall be certified by the manufacturer for the actual shipped unit. The output rating shall be capable of the design conditions identified in this specification. The genset shall also meet the following minimum industry standards: ISO 3046; BS 5514, DIN 6271, SAE J1349 and API 7B-11C.

C.  Engines shall be able to deliver rated power at design ambient when operating Natural Gas.
D. Generators shall start, achieve rated voltage and frequency, and be capable of accepting load within 10 seconds when properly equipped and maintained.

E. The generator set shall be capable of accepting a 100% block load as applied in a single step and shall be able to recover to a steady state condition within the timeframe identified in the following paragraph. Generator transient response performance shall conform to ISO 8528. No other definition of transient response shall be accepted.

F. The maximum voltage dip shall be no greater than that identified in the following paragraph. The voltage dip shall be identified as that recorded by a light beam oscilloscope and strip chart recorder. No other definition of voltage dip shall be accepted.

G. The power generating system shall satisfy the following performance criteria at site conditions:

- Total of Power Capability: as shown
- Frequency: 60 Hz
- 3 Phase Volts: as shown
- Allowable Voltage Dip: 25%
- Average Power Factor: 0.8
- Altitude: per site location
- Design Ambient Temperature: 110 F
- Fuel Type: Natural Gas
- Total air restriction: 0.75” (for use with enclosures)

The bidding manufacturer is required to provide a product that meets the designed power capability at the design ambient and air restrictions. If the manufacturer’s product and output rating is not based on the above ambient conditions, than they are responsible for providing a product that is capable for producing the specified rating at the design conditions. Any de-rating requirements must be clearly identified on page one of the Bidder’s bill of materials.

1.05 EQUIPMENT ALTERNATIVES

A. In additional to submittal requirements contained in other parts of this specification, data for substitute equipment shall be made a minimum of ten (10) days prior to bid date and include the following:
   1. Plan Drawing - Verification that substitute equipment will fit into the space allocated and allow for removal and service.
   2. Air Flow Requirements - Provision for combustion, ventilating, and radiator cooling air.
   3. Product Rating conditions and any required de-rating for operating conditions other than design conditions noted in this specification shall be clearly noted and highlighted by the bidder.
   4. Connections - Wiring and piping diagrams describing interconnect changes.
   5. Load Study - Complete load review to confirm that generating equipment operates satisfactory and complies to original specification during all phases of operation, including motor starting and transient loading capabilities.
   6. Specifications - Specification sheets and support literature to show that alternate equipment is in compliance with all specifications.
   7. Certification - List of projects using similar equipment operating under similar design conditions for the last five years. Copies of certified site test reports shall also be provided with ambient conditions listed on the reports.
   8. Exceptions - All deviations from these specifications shall be clearly highlighted and noted in the bill of materials.

PART 2 - PRODUCTS

Atlanta Airport AC Hotel  Emergency Standby Generator (Natural Gas)  216014.00  26 32 10.3
2.01 MANUFACTURER
A. The equipment shall be as manufactured by Caterpillar, Kohler Generac or Cummins provided the product being offered meets this specification as defined within the content.
B. All components shall have been designed to achieve optimum physical and performance compatibility and prototype tested to prove integrated design capability. The complete system shall have been factory fabricated, assembled and production tested by the manufacturer.
C. Special ratings and non-standard consists will not be accepted. Published specification sheets must be produced for the product being offered. The manufacturer shall have the product being offered installed in a minimum of 20 sites.
D. Prototype and production testing must be performed for the specific rating and consist being offered and certified test reports shall be provided.

2.02 ENGINE
A. The engine shall be spark ignition type natural gas fueled four (4) cycle, water-cooled, vertical in-line or vee-type, operating with nominal speed not exceeding 1800 RPM.
B. The engine shall have a battery charging DC, alternator with a transistorized voltage regulator. Starting shall be a solenoid shaft, electric starter.
C. Engine speed shall be governed by an isochronous electronic governor to maintain 0% droop from no load to full load and +/- 0.25% steady state frequency variation.

2.03 GENERATOR
A. The synchronous generator shall be a single bearing, self-ventilated, drip-proof design in accordance with NEMA MG 1 and directly connected to the engine flywheel housing with a flex coupling.
B. The insulation material shall meet NEMA standards for Class H insulation and be vacuum impregnated with epoxy varnish to be fungus resistant. The excitation system shall be of brushless construction.
C. The brushless exciter shall be independent of main stator windings (either permanent magnet or auxiliary windings) and shall consist of a three-phase armature and a three-phase full wave bridge rectifier mounted on the rotor shaft. Surge suppressors shall be included to protect the diodes from voltage spikes. Generator shall have the ability to sustain short circuit current of 300% of rated current for ten (10) seconds and sustaining 150% of continuous load current, and two (2) minutes with field setup for normal rated load excitation.
D. The automatic voltage regulator (AVR) shall maintain generator output voltage within +/- 0.5% for any constant load between no load and full load. The regulator shall be a totally solid state design which includes electronic voltage buildup, volts per Hertz regulation, over-excitation protection, shall limit voltage overshoot on startup, and shall be environmentally sealed.
E. The generator shall inherently be capable of parallel operation with other power sources of equivalent electrical characteristics.
F. Generator shall be equipped with an AC single phase space heater to minimize condensation while the generator set is idle. The heaters shall be capable of easily mounting in the assembled alternator.
2.04 LUBRICATION SYSTEM

A. The lubrication oil pump shall be a positive displacement type that is integral with the engine and gear driven from the engine gear train. The system shall incorporate full flow filtration with bypass valve to continue lubrication in the event of filter clogging. The bypass valve must be integral with the engine filter base or receptacle. The oil filter shall incorporate a self-lubricating, free rotating seal and have a nonmetallic core sufficiently rigid to minimize movement or shifting of the filtration media.

2.05 FUEL SYSTEM

A. All fuel piping shall be black iron or flexible fuel hose rated for this service. No galvanized piping will be permitted.

B. Flexible fuel lines shall be rated for 300 degrees F and 100 PSI.

2.06 GOVERNOR

A. The engine governor shall control engine speed and transient load response within commercial and ISO 8528 tolerances. It will be selected, installed, and tested by the generator set manufacturer.

B. The engine governor shall be a minimum quality of a Caterpillar ADEM or Woodward 2301 Governor. Speed droop shall be externally adjustable from 0 (isochronous) to 10% from no load to full rated load. Steady state frequency regulation shall be +/- 0.25 percent. Speed shall be sensed by a magnetic pickup off the engine flywheel ring gear. A provision for remote speed adjustment shall be included. In the event of a DC power loss, the forward acting actuator will move to the minimum fuel position.

2.07 COOLING SYSTEM

A. A radiator with blower fan shall be provided to maintain safe operation at the specified ambient temperature. Air flow restriction through the radiator shall not exceed 0.5” H2O. Provide ductwork with flexible connection between radiator and discharge louver frame.

B. A radiator with blower fan shall be provided to maintain safe operation at the specified ambient temperature. Air flow restriction through the radiator shall not exceed 0.5” H2O. Provide ductwork with flexible connection between radiator and discharge louver frame.

C. The radiator shall be sized to cool the engine continuously while operating at full rated load and at site conditions based on a site air flow restriction of 0.5” and a minimum ambient temperature of 110-degrees F. Any required additional de-rations of the radiator resulting from placing the genset inside a standard enclosure, sound attenuated enclosure or inside a building, shall be taken into consideration by the system supplier.

D. The radiator shall be supplied with a 50/50 glycol mixture.

E. Provide an engine jacket water heater with thermostat to maintain coolant temperature at not lower than 90 degrees F. Manual shutoff valves shall be incorporated to isolate the jacket water heater during servicing.

2.08 INLET AIR SYSTEM

A. The engine air cleaner shall be engine mounted with dry element requiring replacement no more frequently than 250 operating hours or once each year. If external ducting is required, maximum
restriction to the combustion air inlet shall be 27 in H2O with air flow of 932 cfm. Design inlet air restriction shall be based on 0.75" H2O for use with an enclosure or 0.50" for use inside a building.

2.09 EXHAUST SYSTEM

A. Outdoor Exhaust System – A critical grade exhaust silencer, companion flanges and flexible stainless steel exhaust fittings shall be provided according to the manufacturer’s recommendations. The silencer shall be mounted so that its weight is not supported by the engine. Exhaust pipe size shall be sufficient to ensure that exhaust back-pressure does not exceed the maximum limitations specified by the engine manufacturer.

For non-sound attenuated enclosures, the muffler shall be designed for mounting on top of the enclosure. For sound attenuated enclosures, the muffler shall be designed for mounting inside the enclosure and the manufacturer shall provide insulation for the muffler and flexible connection.

2.10 WIRING AND CONDUIT

A. Engine and generator control wiring shall be multi-strand annealed copper conductors encased by cross-linked polyethylene insulation resistant to heat, abrasion, oil, water, antifreeze, and diesel fuel. Wiring shall be suitable for continuous use at 120C (250F) with insulation not brittle at -50C (-60F). Cables shall be enclosed in nylon flexible conduit which is slotted to allow easy access and moisture to escape. Reusable bulkhead fittings will attach the conduit to generator set mounted junction boxes.

2.11 ELECTRICAL STARTING SYSTEMS

A. The engine starting system shall include 24 volt DC starting motor(s), starter relay, and automatic reset circuit breaker to protect against butt engagement.

B. A belt driven battery charging alternator shall be provided with transistorized voltage regulator. Voltage shall match the electric starting system.

C. Batteries shall be maintenance free, lead acid type mounted near the starting motor and supplied with a corrosion resistant battery rack. Required cables will be furnished and sized to satisfy circuit requirements. The system shall be capable of starting a properly equipped engine within 10 seconds at ambient temperatures greater than –10 Degrees F. For gensets above 1000kW, the batteries shall have a 2600 CCA, 380 AH rating and shall be rated for operation in ambient temperatures of –10-degrees F.

D. For generators rated 800kW and below, 10 ampere, dual rate, constant voltage charger shall be provided. For generators over 800kW, a 20 ampere dual rate, constant voltage, battery charger shall be provided. The charger shall accept 120 - 208 - 240 volt AC single phase input to provide 24 volt DC output. It shall be fused on the AC input and DC output, and incorporate current limiting circuitry to avoid the need for a crank disconnect relay. An AC voltage power switch shall be mounted on the face of the charger and shielded from accidental switching. The charger shall include an AC ammeter and voltmeter, a failure malfunction alarm switch, and be housed in a NEMA 1 enclosure suitable for wall mounting.

2.12 VOLTAGE REGULATOR

A. The automatic voltage regulator shall maintain alternator output voltage by controlling the current applied to the exciter field of the alternator.

B. The regulator shall be a solid state design which includes electronic voltage buildup and
overcurrent protection. The voltage regulator shall be equivalent to either a Caterpillar VR3 or DVR. It shall incorporate 1:1 volts per Hertz characteristics with the regulated voltage a linear function proportional to frequency over a 30 to 70 Hz range.

C. The regulator shall be suitable for mounting within or external to the alternator assembly, and have provision for remote voltage level control, using 16 ga shielded wire.

D. As installed, the voltage regulator shall meet the applicable sections of the Canadian Standards Association (CSA), International Electrotechnical Commission (IEC), Institute of Electrical and Electronic Engineers (IEEE), National Electrical Manufacturers Association (NEMA).

2.13 MOUNTING

A. The engine and generator shall be assembled to a common base by the engine-generator manufacturer. The generator set base shall be designed and built by the engine-generator manufacturer to resist deflection, maintain alignment, and minimize resonant linear vibration.

2.14 GENERATOR SET ENCLOSURE – WEATHER PROTECTIVE

A. The complete engine generator set, including generator control panel, and engine starting batteries, shall be enclosed in a factory assembled, weather protective enclosure mounted on a structural steel base.

B. The enclosure shall be constructed of galvatite (corrosion resistant) steel with electrostatically applied powder coated baked polyester paint. It shall consist of a roof, side walls, and end walls. Fasteners shall be either zinc plated or stainless steel.

C. Number of doors on enclosure shall be as required so that all normal maintenance operations, such as lube oil change, filter change, belt adjustment and replacements, hose replacements, access to the control panels, etc., may be accomplished without disassembly of any enclosure components. Access doors shall be fabricated of the same material as the enclosure walls and shall be reinforced for rigidity.

D. Handles shall be key lockable, all doors keyed alike, and hinges shall be zinc die cast or stainless steel. Fasteners shall be zinc plated or stainless steel. Doors shall be of a lift off design allowing one person to remove door if necessary.

E. Air handling will be sized and designed by the manufacturer for 0.5” static pressure drop through enclosure. Intake openings shall be screened to prevent the entrance of rodents.

F. Lube oil and coolant drains shall be extended to the exterior of the enclosure and terminated with drain valves. Radiator access shall be through a hinged, lockable cover on enclosure. Cooling fan and charging alternator shall be fully guarded to prevent injury.

G. Enclosure manufacturer shall internally mount the exhaust silencer and maintain the weather resistant integrity and aesthetic appearance of the system. Externally mounted silencers will not be permitted for safety and aesthetic reasons.

H. Lifting points shall be provided on base frame suitable for lifting combined weight of generator set and enclosure.

2.15 TAUTOMATIC LOAD TRANSFER SWITCHES

A. The amperage rating of the automatic load transfer switch shall be as shown. Each transfer switch shall be 4-pole or 3-pole with cross-over neutral. Manufacturer shall be ASCO, Russell or Zenith.
B. The automatic transfer switch shall be mechanically held on both the emergency and the normal side. The switch shall be double throw with the main contacts rigidly and mechanically interlocked to insure only two possible positions: Normal or Emergency. A manual operator must be provided to enable manual operation without having to assemble the handle.

C. The automatic load transfer control shall be open transition and rated for continuous duty when enclosed in a non-ventilated NEMA 1 enclosure. It shall be rated for all classes of load, including inductive and non-inductive, at 600 volts and tungsten lamp load at 250 volts. The transfer switch portion of the control shall be designed, built and tested to close on an inrush current up to and including twenty (20) times the continuous rating of the switch without welding or excessive burning of the contacts. The transfer switch shall be capable of enduring six thousand (6000) cycles of operation, at rated current, at a rate of six (6) cycles per minute, without failure. One cycle shall consist of one complete opening and closure of both sets of contacts on an inrush current of ten (10) times the continuous rating of the switch.

D. The transfer switch shall be as listed under U.L. 1008. Switch utilizing reversing contactor mechanisms as a means to transfer load are disallowed and will not be considered.

E. The automatic load transfer switch shall include the following accessories:
   1. Engine starting contacts to provide for generator starting.
   2. Full phase protection. Three-phase relays shall be field adjustable, close differential type with 92-95% pickup and 82-85% drop out. Relays are to be connected across live lines.
   3. Test switch, to simulate a power outage.
   4. Adjustable time delay on engine starting to override momentary outages and nuisance voltage dips.
   5. Adjustable time delay on transfer of load to emergency source. Adjustable time delay to open transfer switch contact to allow motor loads to decay.
   6. Adjustable time delay on retransfer of load to normal with 5 minute cool-down timer wherein the generator set runs unloaded after transfer to line.
   7. Plant exerciser to start and run the generator set with or without load each 168 hours for a 30 minute interval. Selector switch will be provided for with-load or without-load testing.
   8. Two auxiliary contacts closed on emergency and two auxiliary contact open on emergency.
   9. Pilot lights to indicate the normal and emergency position of the transfer switch.
  10. Isolated (underground) neutral bar.
  11. Disconnect plug.

2.16 CONTROLS, PROTECTION & MONITORING

A. The controls, protection, and monitoring systems of the generator set and its operation shall be the responsibility of the generator set manufacturer. All subsystem components, interfaces, and logic shall be compatible with engine mounted devices.

B. The control panel shall be shock mounted on the generator and have the capability to face either side or the rear of the generator and shall control, protect, meter and annunciate all functions necessary to confirm the operational status of the generator set.

C. The control panel shall be sealed in a dust tight and watertight module with sealed wire entries into the enclosure so as to protect the circuitry and internal components from oil, soot, fumes, diesel fuel, dirt, moisture and debris. The panel module shall comply with NEMA 4 for environmental protection, while the total panel shall qualify for IEC 144 and NEMA 12.

D. The 24 volt DC system shall incorporate energize to run logic and include:
   1. Control: Alternator voltage level rheostat and ammeter/voltmeter phase selector switch shall be mounted on the panel door. The engine start-stop switch shall be door mounted and include positions for off/reset, run, start and automatic mode. Start-stop logic shall have
provisions for cycle cranking programmable from 5-60 second cycles, for total crank time of 5-120 seconds. Cooldown operation shall be programmable from 0-30 minutes with a signal to allow removal of the load from the generator set during cooldown.

2. **Shutdowns/Annunciation:** The generator set shall shut down and red flashing LEDs shall signal operational faults of overcrank, overspeed, high water temperature, and low oil pressure. High water temperature, low coolant level, and low oil pressure shall be programmable for shutdown or alarm. A minimum of three (3) spare fault inputs shall be available which can be programmed for alarm or shutdown, with 0-250 second time delay. There shall be a lamp test switchpad accessible from the front of the panel.

3. **Monitor:** Monitoring devices shall include AC voltmeter, AC ammeter, ammeter/voltmeter phase select switch, frequency meter, electric hour-meter, oil pressure, water temperature, engine RPM, battery DC volts, oil pressure, and jacket water temperature.

4. **Safety Devices:** ISO red emergency stop pushbutton shall be provided, and all controls, annunciation, and monitors labeled with ISO symbols.

5. **Protection:** A lockable door shall be included which is bottom hinged to allow full panel exposure when open.

E. A cycle crank timer shall provide five 10 second cranking periods separated by 10 second rest periods. A cool down timer shall provide an adjustable 0-30 minute engine running period before shutdown after removal of load.

2.17 **ALARM - NFPA 99**

A. NFPA-99 requirements for local annunciation shall be satisfied by a solid state panel which includes a common red indicating light and silencable alarm horn to annunciate all alarms and shutdowns provided by the generator set control panel when equipped with the NFPA-99 alarm module.

2.18 **REMOTE ANNUNCIATOR PANEL - NFPA 110**

A. NFPA-110 requirements for remote annunciation shall be satisfied by a remote mounted solid state panel which includes a common red indicating light and silencable alarm horn to annunciate all alarms and shutdowns provided by the generator set control panel when equipped with the NFPA-110 alarm module. The remote annunciator shall have a minimum of 16 lights.

B. Locate the annunciator panel as directed by the Owner.

2.19 **GENERATOR MAIN CIRCUIT BREAKER**

A. The generator main circuit breaker(s) shall be mounted inside the weatherproof enclosure and on the generator in a termination box. The main breaker and distribution breakers shall be sized according to the drawings.

B. The circuit breaker shall be sized such that the generator will be capable of producing the 100% rated kW of the genset at a 0.8 power factor for a minimum of 4 hours. If a molded case breaker is provided, the breaker shall be have a breaker frame size with a minimum of 120% of the full load amperage of the generator. If an insulated case breaker is provided, the breaker can be sized for 100% of the full load amperage of the generator.

PART 3 - EXECUTION

3.01 **EXECUTION**

A. The following articles and paragraphs are intended to define acceptable procedures and practices of manufacturing, inspecting, installing, and testing the generator set and associated equipment.
B. The genset shall be subjected to a full load, resistive load test prior to shipment to the jobsite. The tests shall demonstrate at a minimum the full rated load capability of the genset, voltage, amperage, fuel consumption shall be recorded.

3.02 SHIPMENT TO JOBSITE

A. Delivery shall be FOB to the jobsite by the system manufacturer's authorized dealer.

3.03 INSTALLATION

A. The installation shall be performed in accordance with shop drawings, specifications, and the manufacturer's instructions.

3.04 FIELD QUALITY CONTROL

A. The system supplier shall perform a pre-startup inspection. The complete installation shall be checked for procedural and operational compliance and any deficiencies shall be noted and corrected by the Contractor.

3.05 POST INSTALLATION TESTING

A. Following installation, the following tests shall be performed by the system supplier in the presence of the owner's engineer or designated appointee:

1. PRESTART CHECKS:
   a) oil level
   b) water level
   c) day tank fuel level
   d) battery connection and charge condition
   e) air start supply pressure (if so equipped)
   f) engine to control interconnects
   g) engine generator intake/exhaust obstructions
   h) engine room ventilation obstructions
   i) removal of all packing materials

2. OPERATION:
   a) Load - 1-hours operation at 50% of full load rating. 1 hours at 75% full load rating. 1-hours operation at 100% of full load rating. 0 to 100% step load, 0 to 50% step load, 0 to 75% step load and 15 minute intervals. The following shall be recorded at fifteen minute intervals:
      b) Voltage and amperage (3 phase), frequency Fuel pressure, oil pressure and water temperature Exhaust gas temperature at engine exhaust outlet
         Ambient temperature
      c) Upon successful completion of the above test, the generator set shall be subjected to a 100% block load test and the recovery timeframe to steady state recorded. This test shall be repeated a total of 4 times.
      d) Proper operation of controls, engine shutdown, and safety devices shall be demonstrated and all testing requirements of NFPA 110 shall be met. A resistive type load bank shall be used for this testing and a test report shall be provided at the successful conclusion of the above test.

3.06 MINIMUM SERVICE AND WARRANTY QUALIFICATIONS

A. The manufacturer's warranty shall in no event be for a period of less than five (5) years from date of initial start-up of the system or 1500 operating hours, whichever comes first.

B. The warranty shall include repair parts, labor, reasonable travel expense necessary for repairs at
the jobsite, and expendables (lubricating oil, filters, antifreeze, and other service items made unusable by the defect) used during the course of repair. Applicable deductible costs shall be specified in the manufacturer's warranty.

C. The system supplier shall provide factory trained servicemen and shall have sufficient parts inventory to maintain over the counter availability of at least 90% of any required parts and shall guarantee 100% parts availability within 48 hours from the time an order is entered with the dealer. Manufacturers who do not meet this qualification will be rejected in their entirety.

3.07 ORIENTATION

A. The system supplier shall provide a complete orientation for the owner's engineering and maintenance personnel. Orientation shall include both classroom and hands-on instruction. Topics covered shall include control operation, schematics, wiring diagrams, meters, indicators, warning lights, shutdown system and routine maintenance.

3.08 SERVICE MANUALS AND PARTS BOOKS

A. The system manufacturer's authorized local dealer shall furnish one copy each of the manuals and books listed below for each unit under this contract:

1. OPERATING INSTRUCTIONS - with description and illustration of all switchgear controls and indicators and engine and generator controls.

2. PARTS BOOKS - that illustrate and list all assemblies, subassemblies and components, except standard fastening hardware (nuts, bolts, washers, etc.).

3. PREVENTATIVE MAINTENANCE INSTRUCTIONS - on the complete system that cover daily, weekly, monthly, biannual, and annual maintenance requirements and include a complete lubrication chart.

4. ROUTINE TEST PROCEDURES - for all electronic and electrical circuits and for the main AC generator.

5. TROUBLESHOOTING CHART - covering the complete generator set showing description of trouble, probable cause, and suggested remedy.

6. RECOMMENDED SPARE PARTS LIST - showing all consumables anticipated to be required during routine maintenance and test.

7. WIRING DIAGRAMS AND SCHEMATICS - showing function of all electrical components
SECTION 26 41 00
LIGHTNING PROTECTION

PART 1 - GENERAL

1.01 SUMMARY

A. This Section describes the material and methods required for all UL Master label lightning protection system.

B. All work shall be in compliance with the following:
   1. Underwriters Laboratories (UL)
   2. NFPA 780
   3. Lightning Protection Institute (LPI)

C. The UL "Mater Label" shall be furnished with LPI certification.

1.02 SHOP DRAWINGS

A. The shop drawings shall be complete including all system components, wiring diagrams, devices, parts, installation details, etc.

B. Provide 1/8"=1'-0" scaled plans (minimum 24"x36" sheet) indicating all air terminal locations, downleads, horizontal conductors, grounding locations, bi-metal taps, and the like and all associated details and specifications.

C. Provide 81/2" x 11" submittal with cutsheet of all components to be used.

PART 2 - PRODUCTS

2.01 CONDUCTORS

A. Conductors shall be copper.

B. The angle of any turn shall not exceed 90 degrees nor have a radius smaller than 24".

C. Conductor fasteners shall be non-corrosive metal with ample strength to support the conductor.

D. Fasten conductors on not more than 3"-0".

2.02 CONDUIT

A. Provide 1" PVC conduit routed from roof down to first floor for cable routing.

B. Conduits shall be routed down adjacent to columns, coordinate all conduit requirements and locations with Lightning protection designer.

2.03 AIR TERMINALS
A. Air terminals shall be copper and extend a minimum 10” above the object it protects.

B. Air terminals located on the finished roof surface or where required by window washing equipment shall have flexible type equipped with stainless steel springs.

C. Air terminals shall have a proper base support for the surface on which they are used and shall be securely anchored to the surface.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Ground connections shall be provided as required to comply with NFPA, LPI, and local codes and as necessary for the soil conditions.

B. Provide a counterpoise loop for buildings more than 100 feet above finished grade.

C. Bond lightning protection system grounding to building grounding electrode per NEC.

END OF SECTION 26 41 00
SECTION 26 43 04
SURGE PROTECTIVE DEVICE

PART 1 – GENERAL

1.01 DESCRIPTION

A. The Surge Protection Device ( SPD) covered under this section includes all service entrance type surge protection devices suitable for use as Type 1 or Type 2 devices per UL1449 3rd Edition, applied to the line or load side of the utility feed inside the facility.

B. A SPD located at Service Entrance (see plans for additional SPD devices).

C. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to finish and install surge protection devices.

1.02 QUALITY ASSURANCE

A. Reference Standard: Comply with the latest edition of the applicable provisions and recommendations of the following, except as otherwise stated in this document:
   2. UL 1283.
   5. UL 96A

1.03 SUBMITALLS/QUALITY ASSURANCE – SUBMIT THE FOLLOWING:

A. Package must include show drawings complete with all technical information, unit dimensions, detailed installation instructions, maintenance manual, recommended replacement parts list and wiring configuration.

B. Copies of Manufacturer’s catalog data, technical information and specifications on equipment proposed for use.

C. Copies of documentation stating that the Surge Protection Device is listed by UL to UL1449 3rd Edition, category code VZCA.

D. Copies of actual let through voltage data in the form of oscillograph results for both ANSI/IEEE C62.41 Category C3 (combination wave) and B3 (Ring wave) tested in accordance with ANSI/IEEE C6245.

E. Copies of Noise Rejection testing as outlined in NEMA LS1-1992 (R2000) Section 3.11. Noise rejection is to be measured between 50kHZ and 100MHz verifying the devices noise attenuation. Must show multiple attenuation levels over a range of frequencies.

F. Copies of test reports from a recognized independent testing laboratory, capable of producing 200kA surge current waveforms, verifying the suppressor components can survive published surge current rating on a per mode basis using the ANSI/IEEE C62.41 impulse waveform C3 (8 x 20 microsecond, 20kV/10kA). Test data on an individual module is not acceptable.
G. Copy of warranty statement clearly establishing the terms and conditions to the building/facility owner/operator.

PART 2 – PRODUCTS

2.01 APPROVED MANUFACTURER:

A. External Units:
   1. Current Technology – Transguard3 or TG3 Series 200kA per mode surge rating or approved equal by Liebert, General Electric.

B. Internal Units:
   1. Square D
   2. Eaton
   3. Siemens

2.02 MANUFACTURED UNITS/ELECTRICAL REQUIREMENTS

A. Refer to drawing for operating voltage, configuration and surge current capacity per mode for each location, or you may list locations and information here.

B. Declared Maximum Continuous Operating Voltage (MCOV) shall be greater than 115 percent of the nominal system operating voltage and in compliance with test and evaluation procedures outlined in the nominal discharge surge current test of UL1449 3rd Edition, section 37.7.3. MCOV values claimed based on the component’s value or on the 30-minute 115% operational voltage test, section 38 in UL1449 will not be accepted.

C. Unit shall have no more than 10% deterioration or degradation of the UL1449 3rd Edition Voltage Protection Rating (VPR) when exposed to a minimum of 5,000 repeated category C3 (20kV/10kA) surges. The SPD manufacturer must provide a test report validating the repetitive surge test was performed.

D. Protection Modes UL1449 3rd Edition VPR(6kV, 3kA) for grounded WYE/delta and High Leg Delta circuits with voltages per the contract documents shall be as follows and comply with test procedures outlined in UL1449 3rd Edition section 37.6:

<table>
<thead>
<tr>
<th>System Voltage</th>
<th>Mode</th>
<th>MCOV</th>
<th>B3 Ringwave 6kV, 500A</th>
<th>C3 Comb. Wave 20kV, 10kA</th>
<th>UL 1449 Third Edition VPR Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>120/240</td>
<td>L-N</td>
<td>150</td>
<td>490</td>
<td>980</td>
<td>700</td>
</tr>
<tr>
<td>120/208</td>
<td>L-G</td>
<td>150</td>
<td>570</td>
<td>980</td>
<td>700</td>
</tr>
<tr>
<td></td>
<td>N-G</td>
<td>150</td>
<td>640</td>
<td>1170</td>
<td>700</td>
</tr>
<tr>
<td></td>
<td>L-L</td>
<td>300</td>
<td>500</td>
<td>1600</td>
<td>1200</td>
</tr>
<tr>
<td>277/480</td>
<td>L-N</td>
<td>320</td>
<td>450</td>
<td>1420</td>
<td>1200</td>
</tr>
<tr>
<td></td>
<td>L-G</td>
<td>320</td>
<td>540</td>
<td>1540</td>
<td>1200</td>
</tr>
<tr>
<td></td>
<td>N-G</td>
<td>320</td>
<td>570</td>
<td>1600</td>
<td>1000</td>
</tr>
<tr>
<td></td>
<td>L-L</td>
<td>552</td>
<td>530</td>
<td>2600</td>
<td>2000</td>
</tr>
</tbody>
</table>

E. Electrical Noise Filter - each unit shall include a high performance EMI/RFI noise rejection filter with a maximum attenuation of 54dB per MIL-STD-220B.
1. SPD shall include a EMI/RFI noise rejection filter for all L-N modes as well as a removable filter in the N-G mode.
F. Integral Disconnect Switch
   1. The device shall have an optional NEMA compliant safety interlocked integral disconnect switch with an externally mounted metal manual operator.
   2. The switch shall disconnect all underground circuit conductors from the distribution system to enable testing and maintenance without interruption to the facility’s distribution system.
   3. The switch shall be rated for 600Vac.
   4. The SPD device shall be tested to UL1449 3rd Edition listed with the integral disconnect switch and the UL1449 VPR ratings shall be provided.
   5. The integral disconnect switch shall be capable of withstanding, without failure, the published maximum surge current magnitude without failure or damage to the switch.
   6. The line side of the integral disconnect shall be blocked off so that when the SPD is opened there is no direct access to the voltage present on the line side of the disconnect.

G. The UL1449 Voltage Protective Rating (VPR) shall be permanently affixed to the SPD unit.

H. The UL1449 Nominal Discharge Surge Current Rating shall be 20kA.

I. The SCCR rating of the SPD shall be 200kAIC without the need for upstream over current protection.

J. The SPD shall be listed as Type 1 SPD, suitable for use in Type 1 or Type 2 applications.

K. The SPD shall have the following monitoring options.
   1. Time Date stamp, duration and magnitude for the following power quality events (sags, swells, surges, dropouts, outages, THD, frequency, Volts RMS per phase)
   2. SPD monitoring shall track surge protection and display it as a percentage.
   3. SPD shall provide a surge counter with three categories to be defined as Low Level surge (100A-500A) Medium Level surge (500A-3,000A) High Level surge (>3,000A)
   4. Remote communications via ModBus or Ethernet

PART 3 –EXECUTION/INSTALLATION

3.01 The SPD manufacturer’s technician shall perform a system checkout and start-up in the field to assure proper installation, operation and to initiate the warranty of the system. The technician will be required to do the following:

A. Verify voltage clamping levels utilizing a diagnostic test kit, comparing factory readings to installed readings.

B. Verify N-G connection.

C. Record information to a product signature card for each product installed.

3.02 Unit may be installed on either the line or load side of the main service disconnect. If installed on the line side unit shall be installed with an integral disconnect. If installed on the load side the unit shall be installed on the largest breaker size available. If installed lead length exceeds 5’ installer shall use a low impedance (HPI) cable to reduce the lead lengths effect on the installed performance of the SPD.

PART 4 –PRODUCT WARRANTY
4.01 Warranty on defective material and workmanship shall be for 15 years.

4.02 Copy of Warranty to be sent with submittal.

END OF SECTION 26 43 04
SECTION 26 50 00
LIGHTING

PART 1 - GENERAL

1.01 SUMMARY

A. Provide lighting fixtures complete with all lamps as specified on the Electrical, Architectural, Interior and Lighting Designer Drawings. Provide all supports, brackets, connectors, materials, tools, wiring, controls and labor to provide a complete and operating lighting system.

B. All blemished, damaged or unsatisfactory fixtures shall be replaced in a satisfactory manner as directed by the Architect.

C. Where a fixture type designated has been omitted, cannot be determined or is in conflict with other Drawings or Specifications, request a clarification from the Architect, prior to bid, and provide suitable fixture type as directed.

D. All lamps shall be operating at project completion and for a period of six (6) months after the final acceptance by the Owner.

E. Confirm exact locations of lighting fixtures with the Architectural Reflected Ceiling Plan and mechanical equipment above or on the ceiling.

F. All recessed lighting fixtures shall match the ceiling type and be tested and certified by the fixture manufacturer for the type of mounting.

1.01 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Handle lighting fixtures carefully to prevent breakage, denting and scoring the fixture finish. Do not install damaged lighting fixtures; replace and return damaged units to equipment Manufacturer.

B. Store lighting fixtures in clean, dry space. Store in original cartons and protect from dirt, physical damage, weather and construction traffic.

1.02 SUBMITTALS

A. The following submittal data shall be furnished according to Section 01 33 00 and Section 26 01 00 and shall include but not be limited to:
   1. Lighting fixtures complete with physical dimensions, materials, connector details, voltage, current, installation details, air handling capability, etc.
   2. Lamps complete with base or pin configuration, lumen rating, life expectancy, color temperature, starting characteristics, etc.

PART 2 - PRODUCTS

2.01 LIGHTING FIXTURES

A. Base bid lighting fixtures shall be based on manufacturer and descriptions listed. Alternate fixture manufacturers not specified and proposed by the Contractor shall be submitted for approval prior to base bid.
B. Fixtures are designated on the Drawings by “type” as indicated by a letter that corresponds to a lighting fixture description and specification on the lighting fixture schedule.

C. Each lighting fixture shall comply with NEC Article 410, Energy Independence & Security Act, local codes and the authority having jurisdiction.

D. Provide a lighting fixture complete with lamps, ballasts and required accessories for each lighting fixture shown. Provide all mounting and trim hardware to suit the specific installation and location.

E. All lighting fixtures shall bear a U.L. label.

F. Where fixtures are specified with acrylic lens, provide virgin acrylic with 0.125 inch thickness.

G. Exit lighting fixtures shall meet the requirements of all federal, state and local codes.

2.02 LAMPS

A. Incandescent A-lamps shall be inside frosted and 130 volt rated unless noted otherwise. Par and reflector type lamps shall be 130 volt rated.

B. All lamps shall be as specified on the Lighting Fixture Schedule.

C. Fluorescent lamps in general shall be T8, 48-inch length with initial lumens of 2,950 at 32 watts and an average life of 20,000 hours. If a color is not designated on the Drawings, then provide 3500K color lamps. Ballast and lamps shall be compatible.

D. Acceptable manufacturers are General Electric, Osram-Sylvania or Philips.

2.03 LAMP HOLDERS

A. For incandescent, provide porcelain body and nickel-plated brass socket, prelubricated with silicone compound.

B. For fluorescent, provide white urea plastic body and silver-plated phosphor bronze or beryllium copper contacts. Fluorescent lamp sockets with open-circuit voltage over 300 volts shall be safety type and designed to open circuit when lamp is removed.

C. For compact fluorescent lamps, provide molded thermoplastic body with copper alloy contacts and stainless steel retainer clips. Provide pin configuration to match lamps.

D. For high intensity discharge, provide porcelain body and nickel-plated brass socket, prelubricated with silicone compound. Medium base sockets shall be 4 KV pulse rated.

2.04 BALLASTS

A. General
   1. All ballasts shall be UL listed and CBM certified. Ballasts shall be CSA certified where applicable.
   2. Ballast shall be approved for operating with specified lamp. Ballast shall provide normal rated lamp life as stated by acceptable lamp manufacturer.
   3. Ballast shall be suitable to operate on the voltage system they are connected to and maintain correct lamp operation with 10% fluctuation of rated input voltage with no damage to ballasts or lamps.
   4. Ballast shall have the lowest sound rating available for the lamps specified. Replace noisy ballasts as directed by Engineer at no cost to the Owner.
5. Ballast shall contain no PCBs.
6. Ballasts shall be identical within each fixture type. All ballasts within the same luminaire shall be from the same manufacturer.
7. Ballast shall support a sustained short to ground on open circuit of any output leads without damage to the ballast and without blowing fuses either inside the ballast or in line with the ballast.
8. Ballast shall be suitable to operate in:
   a. Indoor heated or air conditioned spaces: 50ºF to 150ºF ambient.
   b. Outdoor or in unheated spaces: 0ºF to 105ºF.
   c. Un-air-conditioned spaces: 50ºF to 150ºF at rated life in pendant mounted industrial type fixture.
   d. Recess mounted fixtures: in maximum 140ºF ceiling cavity.
   e. With fire-rated covering, clear air space between fixture and covering minimum of 3 inches.
9. Provide ignitor shut-off device for CSA, HX and R ballast similar to Advance LISOD1 series. The device shall disable the ignitor after 15 minutes of pulsing in cases when lamp has failed or has been removed from socket.
10. Ballast for T-4 and T-5 lamps shall have lamp fault interrupter for end of life failure.
11. Manufacturer shall have been manufacturing ballasts for at least 5 years.

B. Fluorescent Ballast
1. Ballast shall be high frequency and operate lamps at a frequency above 25 KHz with less than 2% lamp flicker.
2. Provide rapid start 0.99 power factor ballast, except as noted, with required voltage and frequency.
3. Ballast shall be UL listed Class P with integral resetting thermal protector, and be suitable for use indoor or Type 1 outdoor application.
4. Ballast case temperature shall not exceed 90ºC.
5. Ballast shall have a ballast factor of greater than .875.
6. Ballast shall comply with Federal Communications Commission Part 18C limits for electromagnetic interference and radio frequency interference for non-consumer equipment.
7. Ballast shall provide transient immunity as specified by ANSI C62.41, Category A (formerly IEEE 587, Section B).
8. Ballast shall have lamp current crest factor of less than 1.7.
9. Total harmonics distortion shall be less than 10%.
10. Third harmonic distortion shall be less than 6%.
11. Ballast shall internally limit in-rush current to not exceed 30 times normal operating current for duration of 5 milliseconds.
12. Manufacturer shall provide 5 year written warranty against defects in material or workmanship, including replacement labor cost.
13. Acceptable manufacturers are Magnetek, Motorola, Osram/Sylvania and Advance.

C. T-8 Electronic Fluorescent Dimming Ballast
1. Ballast shall meet criteria for electronic fluorescent ballasts. See above.
2. Smooth continuous dimming range from 100%-1%.
3. Power factor greater than .90.
4. Total harmonic distortion less than 20%.
5. No visible lamp flicker over entire dimming range.
6. Ballast shall be capable of striking lamps at any light level without first flashing to 100% output.
7. Ballast shall be UL listed for operating specified lamps.
8. Ballast shall be inaudible over entire dimming range.
9. Acceptable manufacturer is Lutron.

D. T-4 and T-5 Compact Fluorescent Electronic Dimming Ballast
1. Ballast shall meet criteria for electronic fluorescent ballasts. See above.
2. Smooth continuous dimming range from 100%-5%.
3. Power factor greater than .90.
4. Total harmonic distortion less than 20%.
5. No visible lamp flicker over entire dimming range.
6. Ballast shall be capable of striking lamps at any light level without first flashing to 100% light output.
7. Ballast shall be UL listed for operating specified lamps.
8. Ballast shall be inaudible over entire dimming range.
9. Acceptable manufacturer is Lutron.

E. High Intensity Discharge
1. Provide constant wattage autotransformer (CWA) or high reactance autotransformer high power factor (HX-HPF) type ballast with power factor greater than .90 except as noted.
2. Ballast shall be designed with Class N insulation.
3. Drop out voltage shall be not less than 70% of nominal.
4. For indoor commercial application:
   a. Provide NEMA rated AA@ sound rating.
   b. Ballast shall comply with Federal Communications Commission Part 18C limits for electromagnetic interference and radio frequency interference.
   c. Ballast shall provide immunity as specified by ANSI C82-4.
5. Acceptable manufacturers are Magnetek, Osram/Sylvania, Advance, and Valmont.

2.05 EMERGENCY BATTERY LIGHTING

A. Lighting fixtures indicated on the drawings to be provided with an emergency battery ballast shall provide emergency lighting by using standard fluorescent lamp or lamps and an emergency battery ballast. The ballast shall consist of a field replaceable high temperature, maintenance free nickel cadmium battery, charger and electronic circuitry contained in one metal case. Provide a solid state charging indicator light to monitor the charger and battery, double pole test switch and installation hardware. The battery ballast shall provide power to the fluorescent lamp upon failure of the normal supply to the fixture.

B. The test button and indicator light shall be integral in the fixture reflector and shall be positioned within or on the surface of the fixture so as to be accessible and identifiable.

C. Under normal mode the battery ballast shall keep the batteries at full charge. Upon loss of normal power the battery ballast shall operate the fluorescent lamp or lamps for 90 minutes.

D. Battery recharge time shall not exceed 16 hours to fully recharge and shall not exceed 225 milliamperes charging current.

E. The lumen output of the lamp or lamps powered by battery unit shall be not less than 1100 lumens initially for a four foot fluorescent lamp.

F. The battery ballast shall meet or exceed all the requirements set forth in UL924 “Emergency Lighting and Power Equipment” and shall be UL listed for installation on top of or remote from the fixture. Emergency illumination shall meet or exceed the requirements set forth in the National Electric Code, Life Safety Code and UL 90-Minute Requirements.

PART 3 - EXECUTION

3.01 GENERAL

A. Locations on the Drawings are diagrammatic. Verify exact locations with Architectural Reflected Ceiling Plans and coordinate space conditions with other trades.
B. Modify locations in mechanical equipment rooms to suit the conditions of the mechanical
equipment while maintaining a sufficient and uniform lighting level equal to that provided by the
layout shown on the Drawings.

C. Fixtures of the same type and in the same ceiling shall have lamps, socket assembling and door
hinges oriented in the same direction.

D. Reflector cones, baffles, aperture plates, light controlling element for air handling fixtures and
decorative elements shall be installed after completion of ceiling tiles, painting and general
cleanup.

E. Target and focus adjustable lighting fixtures after regular working hours and before building
acceptance. Permanently indicate targeting on fixture and provide positive locking devices to
preclude mis-focus relamping. Target and focus in the presence of the Architect and Lighting
Designer.

F. Relamp all incandescent and low-voltage fixtures immediately prior to Owner’s acceptance of
building. Replace non-operating, damaged or darkened fluorescent and high intensity discharge
lamps immediately to Owner’s acceptance of building.

G. Clean all fixture reflectors, lenses, louver, decorative accessories and lamps immediately prior to
Owner’s acceptance of building. Destaticize plastic lenses and diffusers after cleaning.

H. Lighting fixtures mounted within, under, on or integral with millwork shall be given special
consideration. Fixture counting and sizes shall be coordinated with the applicable space and
adjusted accordingly. This coordination shall occur prior to ordering fixtures. Refer to
Architectural Drawings for details.

3.02 SUPPORT OF LIGHT FIXTURES

A. Support directly from building structure, any lighting fixture which weighs in excess of the capacity
of the suspended ceiling on which it is installed. Support each such fixture with the quantity of
threaded rods or fixture support wires required to prevent fixture warping; however provide no
less than two rods or wire per fixture.

B. Outlets, which are recessed in a suspended ceiling and support the weight of surface-mounted or
suspended fixtures, shall be supported from a channel spanning and secured to the ceiling
support system. Support each end of the channel with a fixture support wire attached to
structure.

C. Installation in grid-type suspended ceiling:
   1. Support each corner of a grid opening, in which a lay-in fixture is located, with a fixture
      support wire attached to structure. Provide a support clip, securely fastened to the ceiling
      grid, at or near each corner of each lay-in fixture.
   2. Support fixtures, which are smaller than the ceiling grid opening and which are recessed in
      the acoustical panel, with at least two metal channels spanning, and secured to, the ceiling
      grid. Support each end of each channel or each corner of the grid opening with a fixture
      support wire attached to structure. Do not support fixtures by ceiling acoustical panels.

D. Provide additional supports as required by local codes and seismic zone.

END OF SECTION 26 50 00
SECTION 26 50 10
LIGHT FIXTURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Materials, labor, equipment, and services necessary to furnish, deliver, and install all work of this section as shown on the drawings, as specified herein, and/or as required by job conditions.

B. The work shall include but not be limited to the following:
   1. Complete shop fabrication
   2. Delivery to job site
   3. Installation at designated locations, and controls as noted
   4. Lamping and lamps
   5. Lamp focusing
   6. Cleaning and protection

C. Lighting fixture designations are indicated on the contract documents by an alpha-numeric designation adjacent to each lighting fixture symbol or by a note for areas where fixtures are alike.

1.2 DESCRIPTION OF WORK:

A. Furnish and install a lighting fixture of the type indicated at each location shown on the drawings.

B. All materials, accessories, and any other equipment necessary for the complete and proper installation of all lighting fixtures included in this Contract shall be furnished by the Contractor.

C. Conformance: Fixtures shall be manufactured in strict accordance with the Contract Drawings and Specifications.

D. Codes: Materials and installation shall be in accordance with the latest revision of the National Electrical Code and any applicable Federal, State, and local codes and regulations.

E. Nationally Recognized Testing Laboratory: All fixtures shall be manufactured in strict accordance with the appropriate and current requirements of Nationally Recognized Testing Laboratory standards for safety. A NRTL listing shall be provided for each fixture type, and the appropriate label or labels shall be affixed to each fixture in a position concealing it from normal view.

F. Specifications and scale drawings are intended to convey the salient features, function and character of the fixtures only, and do not undertake to illustrate or set forth every item or detail necessary for the work.

G. Minor details, not usually indicated on the drawings nor specified, but that are necessary for the proper execution and completion of the fixtures, shall be included, the same as if they were herein specified or indicated on the drawings.

H. Omissions: The Owner shall not be held responsible for the omission or absence of any detail, construction feature, etc. which may be required in the production of the fixtures. The responsibility of accurately fabricating the fixtures to the fulfillment of this specification rests with the Contractor.
1.3 REFERENCES

A. Comply with the following in accordance with Division 1.

1. NFPA 70 2011 National Electrical Code
2. CBM Certified Ballast Manufacturer
3. NTRL A nationally recognized Testing Laboratory
4. ASTM American Society of Testing and Materials
5. NEMA National Electrical Manufacturers Association
6. ANSI American National Standards Institute

1.4 BIDDING

A. Follow bidding procedures as described in General Conditions Sections of this Specification.

B. Provide unit and alternate prices as required in Fixture Description part of this specification section.

1.5 SUBSTITUTIONS Refer 01 25 01 – Request for Substitutions

1.6 SUBMITTALS Refer 01 33 00 – Submittals

1.7 SAMPLES:

A. After shop drawing approval, and prior to release for manufacturing, the Contractor shall furnish one sample of each fixture, if requested by Architect, on the fixture schedule and contract drawings for which sample requirement is noted.

B. Shipping: The samples shall be complete with specified lamp(s) ready for hanging, energizing, and examining, and shall be shipped, prepaid by Contractor, to the Lighting Consultant, or as otherwise advised.

C. Sufficient time shall be allowed for thorough examination of the samples by the Lighting Consultant.

D. Samples are not returnable, nor included in quantities listed for a project.

E. Samples must be actual working unit of materials to be supplied.

1.8 QUALITY ASSURANCES

A. The Manufacturer shall be a specialty lighting firm who has been in the business of designing and manufacturing specialty lighting fixtures for not less than ten (10) years.

B. The Installer, if not the manufacturer, shall be a firm having trained personnel who have been in the business of installing specialty lighting for not less than seven (7) years and shall provide a full time field superintendent who shall be a representative of the installer during the installation and testing.
1.9 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site ready for use in the manufacturer's original and unopened containers and packaging, bearing labels as to type of material, brand name, and manufacturer's name. Delivered material shall be identical to the reviewed submittals.

B. Store materials under cover in a dry and clean location, off the ground. Remove materials that are damaged or otherwise not suitable for installation from the job site and replace with acceptable materials.

C. The fixtures shall be delivered to the job site fully fabricated and assembled and ready for installation. Lamps shall be shipped separately.

D. For luminaires incorporating Alzak cones or reflector/cones for protection pending completion of the installation: these components shall be supplied bulk packed in cartons separate from the luminaires. Unit packaging of cones or reflector/cones with luminaires is not acceptable.

1.10 WARRANTY

A. Installation checkout: Upon completion of initial system installation and fixture cleaning, the trade subcontractor shall notify the Architect that the system has been completed. At this time, the subcontractor shall verify that the installation has been done in full accordance with the design and specification and is in full and complete working order.

B. The Trade Subcontractor and Manufacturer shall guarantee all lighting fixtures and major components, except lamps, for a period of two (2) years and (5) years for all LED fixtures after acceptance of the project and final payment is made. The guarantee shall be in an acceptable form and shall be signed and notarized by a person or persons authorized to execute such a document on behalf of the company.

C. Fluorescent electronic ballasts manufacturer(s) shall be regularly employed in the manufacturer of electronic ballasts and have a minimum of 3 years experience in the manufacturing of electronic ballasts.

1. Furnish the electronic ballast manufacturers’ warranty.

2. Warranty period shall not be less than 5 years from the date of manufacture of the electronic ballast. If ballast fails within the warranty period, manufacturer shall promptly replace defective ballast and reimburse the Owner for replacement labor charges. Replacement ballast shall be identical to, or an improvement upon, the original ballast design.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. All materials, accessories, and other related fixture parts shall be new and free from defects which in any manner may impair their character, appearance, strength, durability and function, and be effectively protected from any damage or injury from the time of fabrication to the time of delivery and until final acceptance of the work.
B. Enclosures: Fabricate fixture enclosures with a minimum of #20 gauge (0.0359 inch) thick cold rolled sheet steel. Enclosures may be constructed of other metals, provided they are equivalent in mechanical strength and acceptable for the purpose. Fabricate lighting fixtures to be finished in vitreous porcelain enamel from a minimum of #20 gauge enameling steel.

C. Sheet Metal Work: All sheet metal work shall be free from tool marks and dents, and shall have accurate angles bent as sharp as compatible with the gauges of the required metal. All intersections and joints shall be formed true of adequate strength and structural rigidity to prevent any distortion after assembly.

D. Housings shall be so constructed that all electrical components are easily accessible and replaceable without removing fixtures from their mountings, or disassembly of adjacent construction.

E. Castings: All castings shall be exact replicas of the approved patterns and shall be free of sand pits, blemishes, scales and rust, and shall be smoothly finished. Tolerance shall be provided for any shrinkage of the metal castings in order that the finished castings will accurately fit in their designated locations.

F. All lamp sockets in lighting fixtures shall be suitable for the indicated lamps and shall be set so that lamps are positioned in optically correct relation to all lighting fixture components. If adjustable socket positions are provided, socket should be preset in factory for lamp specified. If different socket positions are specified for same fixture, sockets shall be preset for each type, and cartons marked accordingly.

G. All fixtures shall be completely wired at the factory.

H. Mounting Frames and Rings: If ceiling system requires, each recessed and semi-recessed fixture shall be furnished with a mounting frame or ring compatible with the ceiling in which they are to be installed. The frames and rings shall be one piece or constructed with electrically-welded butt joints, and of sufficient size and strength to sustain the weight of the fixture.

I. Yokes, brackets and supplementary supporting members needed to mount lighting fixtures to carrier channels or other suitable ceiling members shall be furnished and installed by the Contractor.

J. Hardware: For steel and aluminum fixtures, all screws, bolts, nuts and other fastening and latching hardware shall be cadmium or equivalent plated. For stainless steel fixtures, all hardware shall be stainless steel. For bronze fixtures, all hardware shall be stainless steel or bronze.

K. Temperature: All fixtures and ballasts must operate within the temperature limits of their design and as specified by the Nationally Recognized Testing Laboratory in the applications and mounting conditions herein specified.

L. Adjustable Angle Fixtures: Each lighting fixture, which has a beam angle adjustment, shall have reliable angle locking devices.

M. Spread Lens Fixtures: Each light fixture, which has a spread lens, shall contain lens orientation locking devices to insure that lens orientation is not disturbed during future lamp replacement or cleaning.
N. NTRL Listing: All fixtures shall be manufactured in strict accordance with the appropriate and current requirements of a Nationally Recognized Testing Laboratory "Standards for Safety", and others, as they may be applicable. A NTRL listing shall be provided for each fixture type, and the appropriate label or labels shall be affixed to each fixture in a position concealing it from normal view.

O. All access hardware shall be captive type construction.

P. All exposed metallic and non-metallic parts of fixtures such as the fixture body, pendants, canopies, filters, trims, and louvers shall be finished as specified or detailed. When color or finish is not specified, it shall be as directed by the Architect. The finish of fixtures shall be uniform in quality and free from defects such as whirls, discoloration, sand or dust spots, cracks or chips.

Q. Recessed lighting fixtures shall have a thermal protective device in the fixture housing.

R. Lighting fixtures of the same family, i.e. all varieties of recessed downlights or all custom pendants and sconces, shall be the product of one manufacturer, unless otherwise specified.

2.2 LIGHTING FIXTURE COMPONENTS

A. Reflectors and Trims

1. Installation: Reflectors, reflector cones and visible trim of all lighting fixtures shall not be installed until completion of plastering, ceiling tile work, painting and general clean-up. They shall be carefully handled to avoid scratching or finger-printing and shall be, at the time of acceptance by the Owner, completely clean.

2. Downlight reflectors and cones shall be fabricated from 3002 alloy, 99.5% pure non-iridescent aluminum reflector sheets with uniform grain structure, 0.050 inch or heavier unless otherwise shown on drawings; all reflecting surfaces shall be absolutely free from any tooling marks including spinning lines or indentation caused by riveting or other assembly techniques. Reflector surface to be mechanically buffed, then colored with jeweler buffs. No rivets, springs or other hardware shall be visible after installation.

3. Reflectors to be acid and alkaline cleaned to remove forming and polishing compounds, bright dipped in phosphoric and nitric acid. Anodic coating shall be a minimum 0.25 mils for clear reflectors. Specular reflectance to be 86% to 91%.

4. Dyed reflectors to be processed with a lightfast rating no less than 7. All reflectors to be double sealed, first in nickel acetate, second in Sandoz Andal sealant.

5. Upper reflectors for compact fluorescent lamps shall be of a non-iridescent material, 99.85% purity, aluminum flash coating.

6. Cones for compact fluorescent fixtures shall be of a non-iridescent, highly pure aluminum of 99.98% purity, aluminum flash coating.

B. LENSES

1. Plastic for lenses and diffusers shall be formed of colorless 100% virgin acrylic as manufactured by Rohm & Haas, Dupont or as acceptable. The quality of the raw material must exceed IES, SPI, and NEMA Specifications by at least 100% which, as a minimum standard,
shall not exceed a yellowness factor of 3 after 2,000 hours of exposure in the Fade-meter or as
tested by an independent test laboratory. Acrylic plastic lenses and diffusers shall be properly
cast, molded or extruded as specified, and shall remain free of any dimensional instability,
discoloration, embrittlement, or loss of light transmittance for at least 15 years. The minimum
unpenetrated thickness of acrylic lenses shall be 0.125 inches. Acrylic overlay panels shall be
a minimum of 0.040 inches and shall be high transmission type.

2. Polycarbonate lenses shall be .125 inches thick and shall be able to withstand UL impact and
wet label testing.

3. Glass used for lenses, refractors, and diffusers in incandescent lighting fixtures shall be
tempered for high impact and heat resistance. The glass shall be borosilicate, crystal clear in
quality with a transmittance of not less than 88%.

4. All lenses shall be held in a 16 gauge frame work. Lenses that provide access for relamping
shall have their frame hinged to the body of the fixture. Lenses that are not removable shall be
positively attached in place.

5. Provide required lens patterns as specified on schedule.

6. All panels shall be de-staticized at the factory before shipping.

C. LAMP HOLDERS

1. All lamp sockets shall be set so that lamps are positioned in optically correct relation to fixture
components. Lamp sockets shall be rigidly and securely attached by screws to fixture
enclosure or husk, so as to prevent damage to conductor insulation and to prevent socket
turning during lamp replacement. Spring mounted sockets are not acceptable. Plastic or
sheet metal sockets shall not be used unless specified. All lamp sockets shall be UL listed.

2. Medium base lamp holders shall be made of porcelain housing and copper screw shells,
incandescent shall be rated at not less than 660 watts, 250 volts. HID lamps requiring ignitor
system must be rated at 2500 volts minimum.

3. Fluorescent sockets shall have a white urea plastic body and phosphor bronze or beryllium
copper contacts, punch in/twist out type for standard tubular fluorescent lamps, and push-
in/pull-out type for compact fluorescent lamps.

D. BALLASTS, TRANSFORMERS AND CONTROL GEAR

1. Ballasts shall conform to NTRL and ANSI specifications and shall display labels and/or
symbols of approval by the NRTL and of certification by the Certified Ballasts Manufacturers
Association (CBM) as tested by the Electrical Testing Laboratories (ETL).

2. Provide required voltage and frequency.

3. Lamp and Ballast characteristics shall be matched.

4. Electronic Fluorescent ballasts:
a. Ballasts shall be NTRL Listed, Class P and shall have a sound rating of Class A. Power factor shall be above 95%. Ballasts shall maintain a light output ±15% when operating line voltage is between 90% and 100% (120v and 277v models). All ballasts shall have the following characteristics:

i. Minimum 20 khz high frequency
ii. Total harmonic content shall not exceed 15%.
iii. Minimum ballast factor shall be a range of 0.90-0.93 for normal light output ballasts.
iv. Line current crest factor shall not exceed 1.5

b. Ballasts shall meet the following regulations:

i. ANSI C82.11P
ii. ANSI C82.1 for ballast factor for magnetic ballasts
iii. IEEE 587 (ANSI C62.41) for transient protection

c. Use maximum lamps per ballasts whenever possible, unless specified otherwise in the lighting fixture schedule.

d. Provide ballasts by the following manufacturers (unless otherwise noted in this specification):

i. Advance Transformer Company
ii. MagneTek-Triad
iii. Osram Sylvania, Inc.
iv. Aromat (Metal Halide only)

e. Fixture and ballast combination shall be inaudible in a 27 db room ambient.

f. Ballasts shall not contain polychlorinated biphenyls (PCB's).

h. Fluorescent dimming ballasts shall be high frequency, solid-state (electronic) with a dimming range for of 100% to 1% output without flickering. Ballast housing shall match that of conventional rapid start fluorescent ballasts in order to be interchangeable with same. Ballasts shall be rated to control either 3'-0", 4'-0", or 5'-0" lamps. Power factor shall be above 90%. Dimming ballast shall be included on fixtures to be dimmed. The dimmer manufacturer shall approve dimming ballasts.

5. Compact Fluorescent ballasts:

Electronic compact fluorescent ballast shall have a minimum of .9 power factor. Ballast shall have "end of life" shut-down circuit.

6. Ballasts located within the complete luminaire assembly shall not raise the ballasts sound rating by more than 3 dB.

7. Ballasts and capacitors shall contain no toxic substances.
8. Ballasts for outdoor use shall be low temperature type (minus 20 degrees F.).

9. Transformers:

10. Drivers:
   a. Shall conform to ISO Standards for LED Drivers and components.
   b. Shall be robustly constructed to protect against moisture and vibration damage
   c. Provide temperature control that will automatically dim LED at peak temperature levels.
   d. Provide constant light output over the life of the LEDs
   e. Provide end of life signal for ease of maintenance
   f. Dim through either DALI, 0-10V dimming or DMX protocols as specified for each respective fixture type

E. LAMPS

1. Lamp wattages and types shall be as designated on drawings, in the lighting fixture schedules and specifications.

2. Provide lamps by the manufacturers specified in the fixture description section of this specification:

3. Contractor to furnish and install all lamps as specified for the individual luminaires or lighting equipment including Owner Furnished, Contractor Installed fixtures.

4. All fluorescent lamps shall be of the type, wattage and specific color designated on the Lighting Fixture Schedule and shall be 85 CRI minimum.

5. All compact fluorescent lamps shall be of the type, wattage and specific color designated on the Lighting Fixture Schedule and shall be 85 CRI minimum.

6. General service incandescent lamps shall be inside frosted, unless otherwise noted on lighting fixture schedule.

7. Lamps of the same source type shall be product of one manufacturer.

8. LED Lamps:
   a. Product: As per Lighting Fixture Schedule
   b. Substitutions: Refer to General Conditions Section and Paragraph above
   c. LEDs: Shall be of the type, wattage, beam spread, and specific color temperature designated in the Lighting Fixture Schedule. Manufacturer's recommended operating temperature shall be met in the design of the luminaires to ensure LED life.
   d. Life and Output: Long life with 70% output at 50,000 hrs. minimum
   e. Warranty: Five year minimum

2.3 FINISHES
A. Painted Surfaces: Synthetic enamel, with acrylic, alkyd, epoxy, polyester, or polyurethane base, stabilized, baked on at 350 degrees Fahrenheit minimum, catalytically or photochemically polymerized after application.

B. White finishes: Minimum of 85 percent reflectance.

C. Selection: Unless otherwise noted, finishes shall be as selected by the Architect.

D. Undercoat: Except for stainless steel, give ferrous metal surfaces a five stage phosphate treatment or other acceptable base bonding treatment before final painting and after fabrication.

E. Unpainted non-reflecting surfaces shall be satin finished and coated with a baked-on clear lacquer to preserve the surface.

F. Unpainted Aluminum Surfaces: Finish interior aluminum trims with an anodized coating of not less than 7 mg. per square inch, of a color and surface finish as selected by the Architect. Finish exterior aluminum and aluminum trims with an anodized coating of not less than 35 mg. per square inch, of a color and surface finish as selected by the Architect.

G. Porcelain Enamel Surfaces: Apply porcelain finishes smoothly. Finish shall be not less than 7.5 mils thick of non-yellowing, white, vitreous porcelain enamel with a reflectance of not less than 85%.

2.4 SOURCE QUALITY CONTROL

A. Temperature: All fixtures and ballasts must operate within the temperature limits of their design and as specified by Underwriters’ Laboratories, Inc. in the applications and mounting conditions herein specified.

2.5 LIGHTING FIXTURES:

Refer to fixture descriptions – Section 26 50 10 Attachment #1.
Refer to Marriott AC Hotel Brand Standards- Interior Product and Finish Specifications for Guestroom and Guestroom Corridor Fixtures

PART 3 - EXECUTION

3.1 LOCATION

A. Locations of fixtures are shown diagrammatically. Verify exact location and spacing with reflected ceiling plans, field conditions and other reference data before ordering of fixtures and during installation.

B. Notify Architect about field conditions at variance with Contract Documents before commencing installation.

C. Coordinate space conditions with other trades before ordering fixtures.

D. Coordinate length of continuous run fixtures with adjacent walls, partitions, coffers and other architectural elements as required prior to releasing fixture order.
3.2 INSTALLATION

A. The installation of lighting shall comply with the provisions of the appropriate codes and standards as well as the latest version of the International Building Code and Industry Standards.

B. All lighting equipment shall be installed complete, including canopies, suspensions of proper lengths, brackets, casings, sockets, holders, reflectors, ballasts, diffusing material, louvers, lamps, recessing boxes, etc.; all wired and assembled and ready for operation.

C. Comply with the Manufacturer’s recommendations for the installation and use of each lighting fixture and accessory, unless otherwise specified.

D. Fixture mounting shall be coordinated with manufacturer before fixtures are shipped. Contractor shall coordinate fixture installation and clearances needed with the work of other divisions.

E. Where fixtures are mounted on or in an accessible type ceiling, provide junction boxes for all light fixtures and extend flexible conduit to each fixture. No more than two fixture tails per junction box.

F. Furnish and install all lamps required, including replacements for burned-out lamps, until final acceptance of the completed work. No lighting fixture will be installed without lamps.

G. If permanent lighting fixtures are to be used in lieu of temporary lighting facilities during the construction period, this shall be done only as permitted by the Architect, who may require that new lamps be installed and fixtures cleaned at the time of turn-over to the Owner.

H. Downlight reflectors and parabolic louvers shall be installed in place after the project is complete and dust-free or shall be cleaned prior to the time of turnover to the Owner. Installer shall wear white gloves to preclude smudging the reflector surface.

I. Upon completion of the work, as determined by the Architect, fixtures shall be clean and free from foreign material, dust, etc. This includes indirect pendants and coves, which shall be blown out using an anti-static nozzle.

J. FIXTURE SUPPORTS: Verify the construction of the spaces where fixtures are to be provided the necessary supports, frames, clamps, hangers for a complete installation.

1. Fixtures shall be supported independently of suspended ceilings, ducts and piping. Recessed fixtures shall be secured to structure, not rest on top of ceiling.

2. Provide hangers from purlins, joists, beams, etc., for support of boxes and fixtures. Provide trapeze hanger supports for fixtures located directly under ductwork. Provide galvanized steel for support hangers, channels and bolts except stems of stem suspended fixtures, which shall match the fixture finish, unless, noted otherwise.

3. Provide a minimum of two supports for each troffer type fixture 2'x2' or large, one at each end of the fixture unless otherwise shown on the Drawings. In addition, provide hold-down clips for recessed fixtures in compliance with Article 410-16.C of the N.E.C.

4. Provide any baffles and gaskets needed to prevent light leaks around fixtures.
5. Plaster frames, angles, and channels for recessed lighting fixtures shall be furnished under this section where required. The manufacturer of the related lighting fixture shall specifically construct plaster frames for the application.

6. Recessed fixtures shall be designed to fit the make and type of ceiling to be installed, and shall include plaster frames where installed in plaster or gypsum board ceilings.
   
a. Recessed fixtures shall be removable from below to allow access to an outlet box in the ceiling, as required by the National Electrical Code.

   b. Recessed mounted lighting fixtures shall be connected to a junction box with flexible conduit. Final connection to light fixture shall be with heat resistant wire of the following type.
      
      i. Recessed fluorescent 120 or 277 volt, No 14 RHH or THHN.
      ii. Recessed incandescent 120 volt, No. 14 AF.
      iii. Minimum flexible conduit size shall be 3/8”.

9. Provide aligner hangers for stem suspended fixtures so that fixtures hang level with vertical stems.

10. Rigidly align continuous rows of lighting fixtures for true in-line appearance.

3.3 FIELD QUALITY CONTROL

A. Field Tests

   1. After installation, adjustment and inspection, functional tests shall be performed of all interior and exterior lighting fixtures. The tests shall demonstrate that the fixtures have been installed properly and function as required by the Contract Documents.

   2. Indoor lighting shall be tested for illumination in accordance with IES Handbook, Reference Volume, 1984, Section 4.

   3. Confirm designed footcandle levels after installation.

3.4 AIMING AND FOCUSING

A. Set all adjustable fixtures as described on plans. Contractor shall notify Architect one week in advance and establish schedule for nights when final aiming will be done. Night Work: Where possible, units shall be focused during the normal working day. However, where daylight interferes with seeing, aiming shall be accomplished at night.

B. All adjustable lighting units shall be aimed, focused, locked, etc., by the Subcontractor under direction of the Lighting Designer. All aiming and adjusting shall be carried out after the entire installation is complete. All ladders, scaffolds, etc. required shall be furnished by the Contractor. As aiming and adjusting is completed, locking set-screws and bolts and nuts shall be tightened securely.

C. Lock the aiming adjustments, set during final aiming, in position. Position must hold during relamping and normal maintenance.
3.5 CLEANUP

At the time of final acceptance by the Owner, all lighting fixtures shall have been thoroughly cleaned with materials and methods recommended by the manufacturers, all broken parts shall have been replaced, and all lamps shall be operative.

3.6 MAINTENANCE

A. Provide a recommendation as to quantities of attic stock and provide this quantity attic stock as part of the Scope for this work for all fixtures, lamp types and decorative glass pieces for the project. Coordinate with Owner delivery schedule and location for storage prior to delivery.

B. Contractor shall be responsible for obtaining from his supplying lighting manufacturers and supply to the Owner, for each type of lighting fixture, a recommended maintenance manual including:

1. Tools required.
2. Types of cleaners to be used.
3. Replacement parts identification lists.
4. Final, as-built shop drawings

END OF SECTION 26 50 10
SECTION 26 90 00
PHOTO VOLTAIC SYSTEM (PV)

PART 1 – GENERAL

1.01 SCOPE OF WORK

A. PV System is an add alternate to the base electrical system design.
B. Contractor shall provide control power for Photo Voltaic System as required.
   a. Coordinate all connection and power requirements with PV System engineer/vendor.
   b. Coordinate integration requirements of PV system into building electrical system with PV vendor/designer.

END OF SECTION 26 90 00
SECTION 28 05 00

GENERAL ELECTRONIC SAFETY REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. The Drawings are schematic and are not intended to show the exact location of devices, etc. or the routing of conduit or cable.

B. Dimensions and information regarding accurate locations of equipment, and structural limitations and finish shall be coordinated and verified with other Divisions of Work. Be prepared to provide dimensions and information regarding the Work of this Division to other trades.

C. The right is reserved to relocate any device a maximum of 10'-0" before it is permanently installed without incurring additional cost to the Contract.

1.02 REFERENCE STANDARDS

A. All work shall comply with the most recently revised versions of all local, state and federal codes, ordinances of the authority having jurisdiction, laws, rules and regulations. Any modifications required by any of the above shall be made without any additional cost to the owner. Where requirements between governing Codes and Regulations vary, the more restrictive provision shall apply.

B. Nothing contained in the Contract Documents shall be construed as authority or permission to disregard legal requirements and regulations. The Contractor shall thoroughly review the Documents and bring any such conflicts to the attention of the Architect and Engineer prior to Installation.

C. All materials shall be new and shall bear the label of U.L.

1.03 DEFINITIONS

A. Provide: to furnish, install and connect.

B. Furnish: to supply all materials, labor, equipment, testing apparatus, controls, tests, accessories and all other items customarily required for the proper and complete application.

C. Install: to join, unite, fasten, link, attach, set-up or connect together, complete, tested, and ready for normal satisfactory operation.

D. Engineer: the Engineer of record.

E. Contract Documents: the complete set of Specifications and Drawings of all Divisions.

F. Work: labor, materials, equipment, accessories, controls and other items required for a complete installation.

G. Concealed: embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces or in enclosures.
H. Conduit: rigid steel; intermediate metal conduit (IMC), plastic conduit (PVC), electrical metallic tubing (EMT), or flexible steel conduit.

I. Exposed: not installed underground or concealed.

J. Equal: equal in quality, workmanship, materials, weight, size, design and efficiency of the specified product, conforming to manufacturers.

K. Supply: to purchase, procure, acquire and deliver complete with related accessories.

L. Authority Having Jurisdiction (AHJ): applicable local, state and federal authorities having jurisdiction over any part of the Scope within this Division and other Divisions.

1.04 SHOP DRAWINGS AND PRODUCT DATA

A. The Contractor shall obtain complete shop drawings, product data and samples from the manufacturers, suppliers, vendors, and all Division 16 Subcontractors, for all materials and equipment as specified herein in various Sections of the Specifications, and shall submit data and details of such materials and equipment for review by the Architect and Engineer. Prior to submission of the shop drawings, product data and samples to the Architect and Engineer, the Contractor shall thoroughly review the shop drawings, product data and samples and certify they are in compliance with the Contract Drawings. Further, the Contractor shall check all materials and equipment upon their arrival on the Project site and verify their condition and compliance with the Contract Documents. Any Work which proceeds prior to receiving reviewed shop drawings shall be modified as required to comply with the Contract Documents and the shop drawings. A minimum period of ten (10) working days, exclusive of transmittal time, will be required in the Engineer’s office each time a shop drawing, product data and/or sample is submitted or resubmitted for review. This time period shall be considered by the Contractor when scheduling his Work. The initial shop drawing review for equipment and materials may be expedited through the mutual consent of the Contractor, Architect, Engineer, and Owner providing the Contractor agrees to submit complete, certified, documented, and coordinated shop drawings for review in accordance with the requirements of the Contract Documents.

B. The review of shop drawings, product data, and samples by the Architect and Engineer shall not relieve the Contractor of the responsibility for dimensions or errors that may be contained therein, or for deviations from requirements in the Contract Documents. It shall be clearly understood that the noting of some errors by the Engineer but overlooking others does not grant the Contractor permission to proceed in error.

C. All shop drawings and product data/submittals shall be submitted in compliance with the requirements of the general and supplementary conditions. No more than four (4) copies of submittal data will be reviewed. Any additional copies will be returned unmarked. The responsibility of copying review comments on any additional copies will rest solely with the contractor.

D. All product data/submittals shall bear the name of the manufacturer to be used.

E. All shop drawings and submittals shall include a stamped indication signifying that the submittal has been reviewed for compliance with the Contract Documents by the Contractor. This stamped indication also represents the fact that the Contractor has checked this submittal for its interaction with all other Divisions and certifies by his signature or initials that all coordination has taken place. The stamp shall include the date, name of the Contracting Firm, the signature of the Contractor, certification of compliance and approval. This stamp shall be on the submittal before the Engineer will review it.
F. The engineer will review an individual submittal not more than twice. If the submittal is rejected again on the second review, the contractor will bare all responsibility for paying for the Engineer’s time for additional reviews. Such payments to the engineer shall be withheld from the next monthly pay application.

G. Shop drawings and/or product data shall be submitted for the following for review:
   1. Switchboards, panelboards, transformers, busway, motor control centers, ground fault system and other equipment associated with the main distribution.
   2. Disconnect switches, fuses, motor starters.
   4. Lighting fixtures, lighting control system, dimming system, emergency batteries and other equipment associated with lighting.
   5. Transient voltage surge protection.
   6. Generator, UPS, transfer switches, batteries, static switches, transition switches, switchgear and other equipment associated with emergency and/or standby back-up power systems.
   7. Devices, receptacles, switches, coverplates, motion sensors. The product data shall include the manufacturers name, model number, size and color.
   8. Conduit, wire, boxes, fittings.

H. Shop drawing shall be submitted as one complete package for all systems. Shop drawing will not be reviewed until all systems are provided to engineer.

1.05 AS-BUILT DRAWINGS

A. The Contractor shall maintain on a daily basis at the Project site a complete set of “Record Drawings”. Project Record Documents shall be maintained as specified in Division 01.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturer’s names and catalog numbers specified in the Contract Documents are intended to describe the material and set the standard of quality. All bids shall be based on material specified. Request for approval of material not specified shall be considered if the request is in written form and submitted to the Architect no later than fourteen (14) days prior to the bid date. All requests shall conform with the provisions of the general and supplementary conditions.

B. When specific names are not stated, only the best available quality of material or equipment shall be submitted for review and used in the installation.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The equipment selections used in the preparation of the Contract Documents will fit into the physical spaces provided and indicated, allowing ample room for access, servicing, removal and replacement of parts, etc. Adequate space shall be allowed for clearance in accordance with the Code requirements and the requirements of the local Authorities having jurisdiction, and the equipment manufacturer’s recommendations.
B. In the preparation of Drawings, a reasonable effort to accommodate acceptable equipment manufacturer’s space requirements has been made. However, since space requirements and equipment arrangement vary according to each manufacturer, the responsibility for initial access, maintenance access, code required access, and proper fit rests with the Contractor.

C. Physical dimensions and arrangements of equipment to be installed shall be subject to the Architect’s and Engineer’s review.

D. No conduit or cable shall be installed in the eight (8) inch high zone directly above the ceiling in tenant areas to allow for tenant build-out and flexibility unless otherwise specifically shown on the Drawings or prior written authorization is received from the Engineer.

E. Accessibility and Clearance:
   1. Equipment, junction and pull boxes shall be installed in accessible locations, avoiding obstructions, preserving headroom, and keeping openings and passageways clear.
   2. Minor adjustments in the locations of equipment shall be made where necessary, providing such adjustments do not adversely affect functionality of the equipment.

F. Scaffolds and staging for installation of electrical work shall be provided under the work of this Division.

3.02 STRUCTURAL FITTINGS

A. Provide the necessary sleeves, inserts, hangers, anchor bolts, and related structural items. Install at the proper time.

B. Openings may have been indicated on the Architectural and Structural drawings. Should any additional openings or holes be required, the same shall be provided at no additional cost to the Owner.

C. Location: At a time in advance of the work, verify openings shown on the Architectural and Structural drawings, and coordinate any additional openings.

D. If the work of this Section requires modification of the Architectural or Structural drawings, Provide new instructions as to requirements for these openings. Submit for review and coordination to Architect.

E. Sleeves shall be supplied for electrical conduits passing through walls or slabs and shall be placed before concrete is poured.

F. Supports shall be fastened to the structure by inserts, anchor bolts, bolting to drilled and tapped structural members, or be welding to the structure.
   1. Welding shall be done by the electric arc method with fully competent welders. Supporting members shall be shop coated with a suitable primer.
   2. Surfaces damaged by installation of supports shall be touched up with primer to match shop coat. Any drilling of structural members shall be approved by the Architect.

G. Flashing:
   1. Wherever conduits pass through the roof or outer walls, base flashing and counterflashng shall be provided.
   2. Such flashing shall be properly installed by skilled workmen, and shall include grouting, mastic or tar application, or other means to insure a permanent, waterproof, neat and workmanlike installation.
   3. Insofar as possible, flashing shall comply with and be similar to requirements for flashing in General Construction Work.
H. Anchor bolts and inserts shall be galvanized and of adequate size and strength for installation of electrical work and shall be placed in forms before concrete is poured.
   1. Placement of bolts in bases shall be done under other Division. Provide detail drawings, templates, and anchor bolts for bases to the General Contractor in time to avoid delaying work schedules.
   2. Expansion shields shall only be used with specific approval of the Architect. Wooden or soft metal plugs shall not be used.

I. Cutting and patching:
   1. All additional cutting, patching and reinforcement of construction of building, subject to review by the Architect, shall be performed under this Section.
   2. Refer to appropriate Division for requirements.

3.03 WEATHERPROOF EQUIPMENT

A. Electrical devices or equipment located in damp, semi-exposed areas shall be weather-resistant. Enclosures shall comply with NEMA Type 3R requirements.

B. Surface mounted outlet boxes shall be cast metal with threaded bolts. Pull or junction boxes shall be cast metal with bolted and gasketed covers.

C. Outlet box covers shall be of a suitable weatherproof type with gaskets, packing glands, weatherproof doors, or other required means to prevent entry of moisture.

D. Lighting fixtures shall be installed with suitable gasket, and UL labeled for location.

3.04 CLEANING

A. Brush and clean work prior to concealing, painting and acceptance. Perform in stages if directed.

B. Painted exposed work soiled or damaged: Clean and repair to match adjoining work before final acceptance.

C. Remove dust and debris from inside and outside of material and equipment.

3.05 WARRANTIES

A. The warranty period for all systems, equipment, components, work, etc. shall be no less than one (1) year, unless specified otherwise hereinafter and shall include at least one (1) full heating season and one (1) full cooling season.

B. The Contractor shall, without cost to the Owner, remedy any defects within a reasonable time to be specified in notice from the Architect. In default thereof, the Owner may have such work done and charge all costs to the Contractor.

C. The start of the Contractor’s warranty period, as defined in the General Conditions, shall commence on the issue of a “Certificate of Substantial Completion”, by the Owner or the Owner’s Representative for each item of material, equipment or system.

D. The Subcontractor shall confer with the General Contractor prior to the bid date concerning the project schedule and determine if there is a need to operate any items of equipment or systems for temporary heating and/or cooling or other reasons prior to “Substantial Completion”. All
required extended warranty costs for equipment, materials, and systems shall be included in the Subcontractor’s bid.

END OF SECTION 28 05 00
SECTION 28 31 00
LIFE SAFETY SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

A. This performance specification provides the minimum requirements for the Life Safety System. The system shall include, but not limited to all equipment, materials, labor, documentation and services necessary to provide and install a complete, operational system to include but not limited to the following functions:
1. Smoke and fire detection.
2. Sprinkler suppression system monitoring and control.
3. Off-premise notification
4. Provide duct smoke detectors or in-duct smoke detectors as applicable for all smoke damper locations. Coordinate quantity and locations with the mechanical drawings. Provide 120V power supply to each smoke damper.
5. Monitoring of back flow preventers and PIV valves as indicated on the Civil Drawings.

B. Drawings are diagrammatic. The devices shown on the plans are for general architectural and owner coordination and shall be considered a minimum; additional devices shall be provided as required as part of this contract. The contractor shall provide all components, devices, and connections necessary to provide a complete and operating system as required by NFPA and the authority having jurisdiction. The contractor shall coordinate with all trades and provide the necessary devices, connections and zone required (included, but not exclusive, duct mounted smoke detectors, sprinkler system flow and tamper switches, HVAC controls, elevator controls, etc.) Provide quantity of audio/visual devices and power supplies as required by NFPA and the authority having jurisdiction.

1.02 MANUFACTURER

A. The manufacturer of the system equipment shall be regularly involved in the design, manufacture, and distribution of all products specified in this document. These processes shall be monitored under a quality assurance program that meets the ISO 9000 requirements.

B. All System components shall be the cataloged products of a single supplier. All products shall be listed by the manufacturer for their intended purpose.

C. Edwards Systems Technology, Inc. products constitute the minimum type and quality of equipment to be installed. Acceptable alternate manufacturers and panels are as follows: Notifier AM 2020, Pyrotronics MXLV.

D. All control panel assemblies and connected field appliances shall be both designed and manufactured by the same company, and shall be tested and cross-listed as to ensure that a fully functioning system is designed and installed. The system supplied under this specification shall be a microprocessor-based, system. The system shall utilize independently addressed, microprocessor-based smoke detectors, heat detectors, and modules as described in this specification.

1.03 ALTERNATES

A. Strict conformance to this specification is required to ensure that the installed and programmed system will function as designed, and will accommodate the future requirements and operations of the building Owner. All specified operational features must be met without exception.
B. All equipment and components shall be the manufacturer’s current model and all equipment shall be by the same manufacturer. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protected premises protective signaling system, access control, and smoke control. The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system.

C. Any other equipment considered equivalent must be submitted to the Engineer of record not less than ten (10) calendar days prior to the bid, for approval. Submitting of material does not constitute acceptance or approval of said equipment. All deviations from the specification must be listed in a point-by-point statement showing compliance or non-compliance with the specifications. The acceptability of any alternate proposed system shall be the sole decision of the Engineer, Owner or his authorized representative.

1.04 REFERENCES

A. General (references)
1. All work and materials shall conform to all applicable Federal, State and local codes and regulations governing the installation. If there is a conflict between the referenced standards, federal, state or local codes, and this specification, it is the bidder’s responsibility to immediately bring the conflict to the attention of the Engineer for resolution. National standards shall prevail unless local codes are more stringent. The bidder shall not attempt to resolve conflicts directly with the local authorities unless specifically authorized by the Engineer.

2. System components proposed in this specification shall be UL listed to operate together as a system. The supplier shall provide evidence, with his submittal, of listings of all proposed equipment and combinations of equipment. The supplier shall be responsible for filing of all documents, paying all fees (including, but not limited to plan checking and permit) and securing all permits, inspections and approvals. Upon receipt of approved drawings from the authority having jurisdiction, the supplier shall immediately forward two sets of drawings to the Owner. These drawings shall either be stamped approved or a copy of the letter stating approval shall be included.

B. Codes
1. Fire - The equipment and installation shall comply with the current provisions of the following codes and standards:
   c. NFPA 90A - 1999 Air Conditioning Systems
   e. UL 864 - Control Units for Fire Protective Signaling Systems.
   f. UL 268 - Smoke Detectors for Fire Protective Signaling Systems.
   g. UL 268A - Smoke Detectors for Duct Applications.
   i. UL 228 - Door Closers-Holders, With or Without Integral Smoke Detectors.
   j. UL 464 - Audible Signaling Appliances.
   k. UL 38 - Manually Actuated Signaling Boxes for Use with Fire-Protective Signaling Systems
   l. UL 346 - Waterflow Indicators for Fire Protective Signaling Systems.
   m. UL 1971 - Signaling Devices for the Hearing-Impaired.
   n. UL 1481 - Power Supplies for Fire Protective Signaling Systems.
   o. Factory Mutual (FM) approval
   p. AHJ
   q. Federal Codes and Regulations
   r. Americans with Disabilities Act (ADA)
1.05 SYSTEM DESCRIPTION

A. General
The Contractor shall provide all labor, services and materials necessary to furnish and install a complete, functional fire alarm system (System). The System shall comply in all respects with all pertinent codes, rules, regulations and laws of the Authority, and local jurisdiction. The System shall comply in all respects with the requirements of the specifications, manufacturer’s recommendations and Underwriters Laboratories Inc. (ULI) listings.

B. System Features
1. Provide and install a new fire detection and alarm system that shall consist of:
   a. Fire Alarm Control Panel.
   b. LCD remote annunciator(s).
   c. Printer.
   d. Manual pull stations, smoke detectors, heat detectors, beam detectors and duct detectors.
   e. Sprinkler system waterflow(s) and valve supervisory switch(s).
   f. Interface with suppression system(s).
   g. Audio/visual devices.
   h. Synchronized visual notification appliances.
   i. Magnetic door holders (coordinate with Architect and door hardware).
2. Provide elevator recall functions for primary and alternate floors and elevator power shunt trip activation.
3. Provide connection to a central station. The owner shall arrange for two dedicated phone lines to be terminated as directed by the installing contractor.

C. Sequence of Operations
1. The alarm activation of any area smoke detector, heat detector, manual pull station, sprinkler waterflow, the following functions shall automatically occur:
   a. The internal audible device shall sound at the control panel and remote annunciator.
   b. The LCD display shall indicate all applicable information associated with the alarm condition including; device type, device location and time/date.
   c. All system activity/events shall be documented in system history and on the system printer.
   d. Any remote or local annunciator LCD/LED’s associated with the alarm shall be illuminated.
   e. Activate notification audible appliances throughout the building or as required by code.
   f. Activate visual strobes notification appliances throughout the building or as required by code. The visual strobe shall continue to flash until the system has been reset. The visual strobe shall not stop operating when the “Alarm Silence” is pressed.
   g. Transmit an alarm signal to the central station.
   h. All automatic events programmed to the alarm point shall be executed and the associated outputs activated.
   i. All stairwell/exit doors shall unlock throughout the building.
   j. All self-closing fire/smoke doors held open shall be released.
2. The Alarm activation of any duct smoke detector, the following functions shall automatically occur:
   a. The internal audible device shall sound at the control panel and remote annunciator.
   b. The LCD display shall indicate all applicable information associated with the alarm condition including; device type, device location and time/date.
   c. All system activity/events shall be recorded on the system printer and system history file.
   d. Any remote or local annunciator LED’s associated with the alarm shall be illuminated.
   e. Transmit signals to remote annunciators located as shown on the contract drawings.
   f. Transmit an alarm signal to the central station.
g. Shutdown the local air handling unit.

h. All automatic events programmed to the alarm point shall be executed and the associated outputs activated.

3. Upon supervisory activation of any sprinkler valve supervisory switch, the following functions shall automatically occur:
   a. The internal audible device shall sound at the control panel and remote annunciator.
   b. The LCD display shall indicate all applicable information associated with the supervisory condition including; device type, device location and time/date.
   c. All system activity/events shall be documented on the system printer and system history file.
   d. Any remote or local annunciator LCD/LED's associated with the supervisory activation shall be illuminated.
   e. Transmit a supervisory signal to the central station.

4. Upon activation of a trouble condition or signal from any device on the system, the following functions shall automatically occur:
   a. The internal audible device shall sound at the control panel and remote annunciator.
   b. The LCD display shall indicate all applicable information associated with the trouble condition including; device type, device location and time/date.
   c. All system activity/events shall be documented on the system printer and system history file.
   d. Any remote or local annunciator LCD/LED's associated with the trouble zone shall be illuminated.
   e. Transmit a trouble signal to the central station.

D. System Configuration

1. General
   a. All Life Safety System equipment shall be arranged and programmed to provide a system for the early detection of fire, the notification of building occupants, the automatic summoning of the local fire department, the override of the HVAC system operation, and the activation of other auxiliary systems to inhibit the spread of smoke and fire, and to facilitate the safe evacuation of building occupants.
   b. The System shall utilize independently addressed, smoke detectors, heat detectors and input/output modules as described elsewhere in this specification.

2. Power Supply
   a. The power supply shall be a high efficiency switch mode type with line monitoring to automatically switch to batteries for power failure or brown out conditions. The automatic battery charger shall have low battery discharge protection. The power supply shall provide internal power and 24 Vdc at 6.0A continuous for notification appliance circuits. All outputs shall be power limited. The battery shall be sized to support the system for 60 hours of supervisory and trouble signal current plus general alarm for 15 minutes. The power supply shall be an EST model 2-PPS6/A.
   b. Auxiliary power supplies shall be a high efficiency switch mode type with line monitoring to automatically switch to batteries for power failure or brown out conditions. The automatic battery charger shall have low battery discharge protection. The power supply shall provide internal power and 24 Vdc at 6.4 continuous for notification appliance circuits. The power supply shall be capable of providing 8A to output circuits for a maximum period of 100 ms. All outputs shall be power limited. The battery shall be sized to support the system for 60 hours of supervisory and trouble signal current plus general alarm for 30 minutes. All supervision of the auxiliary supply shall be transmitted via addressable analog loop without additional equipment. The auxiliary power supply shall be an EST model SiGA-APS.

3. Display
   a. The display module shall be of membrane style construction with a 4 line by 20 characters Liquid Crystal Display. The LCD shall use super-twist technology and backlighting for high contrast visual clarity. In the normal mode display the time, the total...
number of active events and the total number of disable points. In the alarm mode display the total number of events and the type of event on display. Reserve 40 characters of display space for user custom messages. The module shall have visual indicators for the following common control functions; AC Power, alarm, supervisory, monitor, trouble, disable, ground fault, CPU fail, and test. There shall be common control keys and visual indicators for; reset, alarm silence, trouble silence, drill, and one custom programmable key/indicator. Provide four pairs of display control keys for selection of event display by type (alarm, supervisory, monitor and trouble) and forward / backward scrolling through event listings. The operation of these keys shall be integrated with the related common control indicator that lights when an event of its type is active. Allow the first event of the highest priority to capture the LCD for display so that arriving fire fighters can view the first alarm event “hands free”. Provide system function keys; status, reports, enable, disable, activate, restore, program, and test. The module shall have a numeric keypad, zero through nine with delete and enter keys.

b. The display module shall be an EST model 2-LCD.

4. Initiating Device Circuits
   a. The Initiating device circuits (IDC) used to monitor waterflow switches, valve supervisory switches, fire pump functions, and air pressure supervisory switches shall be Class B.
   b. The Initiating device circuits shall be EST Signature series modules.

5. 24 VDC Notification Appliance Circuits
   a. 24 VDC Notification appliance circuits (NAC) shall be Class B. All notification appliance circuits shall have a minimum circuit output rating of 2 amp @ 24 vdc. The notification circuits shall be power limited. Non-power limited circuits are not acceptable.
   b. The 24 VDC Notification appliance circuits shall be EST Signature series modules.

6. Audio Notification Appliance Circuits
   a. One-way audio notification appliance circuits (NAC) shall Class B. All notification appliance circuits shall have a minimum circuit output rating of 35W @70Vrms. The notification circuits shall be power limited. Non-power limited circuits are not acceptable.
   b. The one-way audio notification appliance circuits shall be EST Signature series modules.

7. Signaling Line Circuits
   a. The signaling line circuit shall communicate from a panel/node to analog/addressable detectors, input modules, output modules, isolation modules and notification appliance circuits.
   b. Each signaling circuit connected to addressable/analog devices shall provide a minimum of 20 spare addresses.
   c. When a signaling line circuit covers more than one fire/smoke compartments, a wire-to-wire short shall not effect the operation of the circuit from the other fire/smoke compartments.
   d. The signaling line circuit (SLC) connecting panels and annunciators shall be Class B.
   e. The signaling line circuit connecting to addressable/analog devices including, detectors, monitor modules, control modules, isolation modules, and notification circuit modules shall be Class B.

8. DACT
   a. The panel shall have a dialer (alarm communicator transmitter (DACT)) module to transmit alarm, supervisory and trouble signals to a Central Monitoring Station (CMS). The DACT shall support dual telephones lines, 20 PPS 4/2 communications, and configured for dual tone multi-frequency (DTMF) or pulse modes. It shall be possible to delay AC power failure reports, auto test call, and site program using a touch tone phone and password.
   b. The dialer shall be an EST model DL2.

E. Submittals
   1. Project Submittal
      a. The contractor shall purchase no equipment for the system specified herein until the owner has approved the project submittals in their entirety and has returned them to the
It is the responsibility of the contractor to meet the entire intent and functional performance detailed in these specifications. Approved submittals shall only allow the contractor to proceed with the installation and shall not be construed to mean that the contractor has satisfied the requirements of these specifications. The contractor shall submit ten (10) complete sets of documentation including point to point CAD drawings and submittals within 30 calendar days after award of purchase order.

b. Each submittal shall include a cover letter providing a list of each variation that the submittal may have from the requirements of the contract documents. In addition the contractor shall provide specific notation on each shop drawing, sample, catalog cut, data sheet, installation manual, etc. submitted for review and approval, of each such variation.

c. All drawings and diagrams shall include the Contractor's title block, complete with drawing title, contractor's name, address, date including revisions, and preparer's and reviewer's initials.

d. Product Data - Data sheets with the printed logo or trademark of the manufacturer for all equipment. Indicated in the documentation will be the type, size, rating, style, and catalog number for all items proposed to meet the system performance detailed in this specification. The proposed equipment shall be subject to the approval of the Architect/Engineer.

e. Shop Drawings - A complete set of shop drawings shall be supplied. The shop drawings shall be reproduced electronically in digital format. This package shall include but not be limited to:
   1) Control panel wiring and interconnection schematics.
   2) Complete point to point wiring diagrams. A vertical riser is not acceptable. All drawings must be in CAD.
   3) Detailed system operational description and operational matrix.
   4) Complete system bill of material.

f. All drawings shall be reviewed and signed off by an individual having a minimum of a NICET III certification in fire protection engineering technology, subfield of fire alarm systems.

2. Qualifications of Contractor

a. The contractor shall have successfully installed similar system fire detection, signaling control components on a previous project of comparable size and complexity. The owner reserves the right to reject any control components for which evidence of a successful prior installation performed by the contractor cannot be provided.

b. The contractor shall have in-house engineering and project management capability consistent with the requirements of this project. Qualified and approved representatives of the system manufacturer shall perform the detailed engineering design of central and remote control equipment. Qualified and approved representatives of the system manufacturer shall produce all panel and equipment drawings and submittals, operating manuals. The contractor is responsible for retaining qualified and approved representative(s) of those system manufacturers specified for detailed system design and documentation, coordination of system installation requirements, and final system testing and commissioning in accordance with these specifications.

c. Quality Assurance/Control Installer's Certification
   1) The engineered systems distributor must be licensed in the state of project location and have been incorporated in the business in that state for a minimum of 5 years.
   2) Provide in the submittal a copy of the contractors training certification issued by the manufacturer of the Life Safety System.

d. Provide a copy of the installing technician's NICET certification level III or IV.

e. System Calculations - complete calculations shall be provided which show the electrical load on the following system components:
   1) Each system power supply, including stand alone booster supplies.
   2) Each standby power supply (batteries).
   3) Each notification appliance circuit.
   4) Each auxiliary control circuit that draws power from any system power supply.
3. **Closeout Submittal**  
   a. Four (4) copies of the following documents shall be delivered to the building owner's representative at the time of system acceptance. The close out submittals shall include:  
      1) Project specific operating manuals covering the installed Life Safety System. A generic or typical owner's instruction and operation manual shall not be acceptable to fulfill this requirement.  
      2) As-Built drawings consisting of: a scaled plan of each building showing the placement of each individual item of the Life Safety System equipment as well as raceway size and routing, junction boxes, and conductor size, quantity, and color in each raceway. All drawings must reflect point to point wiring, device address and programmed characteristics as verified in the presence of the engineer and/or the end user unless device addressing is electronically generated, and automatically graphically documented by the system.  
      3) Provide all drawings in standard .DXF format.  
      4) Provide the name, address and telephone of the authorized factory representative.  
      5) A filled out Record of Completion similar to NFPA 72, 1999 edition figure 1-6.2.1.

F. **Warranty and Maintenance**  
   1. **Warranty**  
      a. The contractor shall warranty all materials, installation and workmanship for one (1) year from date of acceptance, unless otherwise specified. A copy of the manufacturer's warranty shall be provided with close-out documentation and included with the operation and installation manuals.  
      b. The System Supplier shall maintain a service organization with adequate spare parts stock within 100 miles of the installation. Any defects that render the system inoperative shall be repaired within 24 hours of the owner notifying the contractor.

2. **Spare Parts**  
   a. The Contractor shall supply the following spare parts:  
      1) Automatic detection devices - Two (2) percent of the installed quantity of each type.  
      2) Manual fire alarm stations - Two (2) percent of the installed quantity of each type.  
      3) Glass rods or panels for break glass manual fire alarm stations (if used) - <Ten> percent of the installed quantity, but no less than two devices.  
      4) Audible and visible devices - One (1) percent of the installed quantity of each type, but no less than two (2) devices.  
      5) Keys - A minimum of three (3) sets of keys shall be provided and appropriately identified.

G. **Training**  
   1. The System Supplier shall schedule and present a minimum of 4 hours of documented formalized instruction for the building owner, detailing the proper operation of the installed System.  
   2. The instruction shall be presented in an organized and professional manner by a person factory trained in the operation and maintenance of the equipment and who is also thoroughly familiar with the installation.  
   3. The instruction shall cover the schedule of maintenance required by NFPA 72 and any additional maintenance recommended by the system manufacturer.  
   4. Instruction shall be made available to the Local Municipal Fire Department if requested by the Local Authority Having Jurisdiction.

**PART 2 - PRODUCTS**

2.01 **MANUFACTURER**

A. Acceptable fire alarm system manufacturers include:
   1. Edwards Systems Technology, Inc.
2. Notifier AM 2020
3. Pyrotronics M5X LV

2.02 PANEL COMPONENTS & FUNCTIONS

A. General
1. The control panel shall be a multi-processor-based system designed specifically for fire and releasing system applications. The control panel shall be listed and approved for the application standard(s) as listed under the General section.

2. The control panel shall include all required hardware, software and system programming to provide a complete and operational system. The control panel shall assure that life safety takes precedence among all panel activities.

3. The control panel shall include the following capacities:
   a. Support up to 380 analog/addressable points per panel (1,900 total, with 5 networked panels).
   b. Support up to 5 fully supervised network remote annunciators.
   c. Support a DACT (dialer) for off premise notification.
   d. Support up to 576 chronological events in history.
   e. Provide 25% spare capacity on each data line.

4. The control panel shall include the following features:
   a. Provide auto-programming and electronic addressing and mapping of analog/addressable devices.
   b. Provide an operator interface display that shall include functions required for annunciation, command and control system functions.
   c. Provide a discreet system control switch provided for reset, alarm silence, local silence, drill switch, up/down switches, status switch, program switch, enable and disable switches, activate and restore switches, reports switch and test switch.
   d. Provide system reports that provide sensitivity and history details.
   e. Provide an authorized operator with the ability to operate or modify system functions like system time, date, passwords; and auto-program, enable mapping, restart the system and clear control panel event history file.
   f. Provide an authorized operator to perform test functions within the installed system.

5. Supervision of system components, wiring, initiating devices and software shall be provided by the control panel. Failure or fault of system component or wiring shall be indicated by type and location on the LCD display. Software and processor operation shall be independently monitored for failure.

B. Annunciation
1. The system shall be designed and equipped to receive, monitor, and annunciate signals from devices and circuits installed throughout the building. Manufacturer's standard control switches shall be acceptable if they provide the required operation, including performance, supervision and position indication. If the manufacturers' standard switches do not comply with these requirements, fabrication of custom manual controls acceptable to the owner is required.

2. Receipt of alarm, trouble, and supervisory signals shall activate integral audible devices at the control panel(s) and at each remote annunciation device.

3. The annunciator shall contain the following system status indicators:
   - 80 character Backlit Liquid Crystal Display
   - System Power Indicator – green LED
   - System Common Alarm – red LED
   - System Common Trouble – yellow LED
   - System Common Supervisory – yellow LED
   - System Common Monitor – yellow LED
   - System Ground Fault – yellow LED
   - System CPU Fault – yellow LED
   - System Disables – yellow LED
System Test Point(s) – yellow LED
System Reset Switch with Integral yellow LED
System Alarm Silence Switch with Integral yellow LED
System Local Silence Switch with Integral yellow LED
System Drill Switch with Integral yellow LED
System Message Queue Scroll Switches
Additional button as required to provide system control and operator functions.

4. The network annunciator(s) shall be an EST 2 series.

C. Power Supply
1. Each system power supply shall be a minimum of 6 amps @ 24 vdc.
2. Upon failure of normal (AC) power, the affected portion(s) of the system shall automatically switch over to secondary power without losing any alarm, trouble or operator acknowledgment signals.
3. Each system power supply shall be individually annunciated and shall identify the inoperable power supply in the event of a trouble condition.
4. All standby batteries shall be continuously monitored by the system. Low battery and disconnection of battery power supply conditions shall immediately annunciate as a trouble signal, identifying the deficient batteries.
5. All system power supplies shall be capable of recharging their associated batteries, from a fully discharged condition to a capacity sufficient to allow the system to perform consistent with the requirements of this section, in 48 hours maximum.
6. All AC power connections shall be to the building's designated emergency electrical power circuit and shall meet the requirements of Section 1-5.2 of NFPA 72 - 1999. The AC power circuit shall be installed in conduit raceway. The power circuit disconnect means shall be clearly labeled FIRE ALARM CIRCUIT CONTROL and shall have a red marking. The location of the circuit disconnect shall be labeled permanently inside the each control panel.
7. The power supply shall be an EST model 2-PPS/6A.

D. Display
1. The system shall allow message routing to be configured to any or all annunciators.
2. All system printer port shall be configurable to output any combination of alarm, supervisory, trouble, or monitor, event messages.
3. Each LCD display on each annunciator shall be configurable to display the status of any combination of alarm, supervisory, trouble, or monitor, event messages.
4. Clear distinction shall be provided between alarm, supervisory, trouble, and monitor status messages.
5. The system shall provide the ability to retrieve data from the analog/addressable detectors to a PC while the system is on-line and operational in the protected premises. The uploaded data may then be analyzed in a diagnostic program supplied by the system manufacturer.
6. A standby power supply shall automatically supply electrical energy to the system upon primary power supply failure.

E. Dialer – DACT
1. The system shall provide an off premise Digital Alarm Communications Transmitter (DACT) capable of transmitting system alarm, trouble and supervisory events to a central monitoring station (CMS). The DACT shall support dual telephone lines, 20 PPS 4/2 communications, and configured for dual tone multi-frequency (DTMF) or pulse modes. It shall be possible to delay AC power failure reports, auto test call, and site program the DACT using a touch tone phone and password.
2. The DACT shall be an EST model DL2.

F. Reports
1. The system shall provide the operator with system reports that give detailed chronological description of the last 576 system events. The system shall provide a report that gives a listing of the sensitivity and environmental compensation usage of all of the detectors on the
2. The system report shall also include facility name, compiled date, compiler revision, project revision and report date. The system shall output these reports via the main LCD, and reports shall be capable of being printed on the system printer.

### 2.03 FIELD-MOUNTED SYSTEM COMPONENTS

#### A. Initiating Devices

1. **Smoke Detectors & Accessories**
   
   a. **Analog Addressable Smoke General**
      
      1) Each analog addressable smoke detector’s sensitivity shall be capable of being programmed individually as: most sensitive, more sensitive, normal, less sensitive or least sensitive.
      
      2) The system shall allow for changing of detector types for service replacement purposes without the need to reprogram the system. The replacement detector type shall automatically continue to operate with the same programmed sensitivity levels and functions as the detector it replaced. System shall display an off-normal condition until the proper detector type has been installed or change in the application program profile has been made.

   b. **Smoke Detector Photoelectric or Photo/Heat**
      
      1) Provide analog/addressable photoelectric smoke detectors as required. The system shall have the ability to set the sensitivity and alarm verification of each of the individual detectors on the circuit. It shall be possible to automatically change the sensitivity of individual analog/addressable detectors for the day and night periods. Each smoke detector shall be capable of transmitting alarm signals as well as normal, trouble and need cleaning information. It shall be possible to program control panel activity to each level. Each smoke detector may be individually programmed to operate at any one of five (5) sensitivity settings. Each detector microprocessor shall contain an environmental compensation algorithm that identifies and sets ambient environmental thresholds approximately six times an hour. The microprocessor shall monitor the environmental compensation value and alert the system operator when the detector approaches 80% and 100% of the allowable environmental compensation value.
      
      2) The analog/addressable photoelectric smoke detector shall be an EST model SIGA-PS.
      
      3) Where required by designed drawings provide a combination photo/heat detector in one device. The unit shall be EST model SIGA-PHS.

   c. **Duct Detector Housing**
      
      1) Provide smoke detector duct housing assemblies to mount an analog/addressable detector along with a standard, relay or isolator detector mounting base. The housing shall also protect the measuring chamber from damage and insects. The housing shall utilize an air exhaust tube and an air sampling inlet tube that extends into the duct air stream up to ten feet. Drilling templates and gaskets to facilitate locating and mounting the housing shall also be provided. The housing shall be finished in baked red enamel. Remote alarm LED indicators and remote test stations shall be provided.
      
      2) The smoke detector duct housing shall be an EST model SIGA-DH.

   d. **Relay Module**
      
      1) Provide addressable control relay circuit modules at the locations shown on the drawings. The module shall provide one (1) form C dry relay contacts rated at 24Vdc @ 2 amps (pilot duty) to control external appliances or equipment. The position of the relay contact shall be confirmed by the system firmware.
      
      2) The addressable control relay circuit module shall be an EST model SIGA-CR.

2. **Fixed Temperature – ROR Heat Detector**

   a. Provide analog/addressable combination fixed temperature / rate-of-rise detectors at the
locations shown on the drawings. The heat detector shall have a nominal fixed temperature alarm point rating of 135°F (57°C) and a rate of rise alarm point of 15°F (9°C) per minute. The heat detector shall be rated for ceiling installation at a minimum of 70 ft (21.3m) centers and be suitable for wall mount applications.

b. The analog/addressable combination fixed temperature / rate-of-rise detector shall be EST model SIGA-HRS.

3. Detector Bases – Standard
a. Provide standard detector mounting bases suitable for mounting on North American 1-gang, 3½ or 4 inch octagon box and 4 inch square box, or European BESA or 1-gang box. The base shall, contain no electronics and support all series detector types.

b. The standard detector base shall be an EST model SIGA-SB4.

4. Manual Station - Double Action Single Stage
a. Provide analog/addressable double action, single stage fire alarm stations at the locations shown on the drawings. The fire alarm station shall be of polycarbonate construction and incorporate an internal toggle switch. A locked test feature shall be provided. The station shall be finished in red with silver "PULL IN CASE OF FIRE" lettering. The manual station shall be suitable for mounting on North American 2 ½ (64mm) deep 1-gang boxes and 1 ½ (38mm) deep 4 square boxes with 1-gang covers.

b. The analog/addressable double action, single stage fire alarm station shall be EST model SIGA-278.

5. Door Holders
a. Provide electromagnetic Floor or Wall mounted door holders as shown on the contract drawings. The door holders housing shall be finished aluminum color, durable, baked polyester powder paint. The floor or wall section houses the electromagnet while the contact plate attaches to the door. The contact plate has a shock absorbing nylon swivel ball which allows the plate to adjust to any door angle. The door holder shall have a holding force of approximately 25Lbf. (111N). The door holders shall be suitable for mounting on North American 2 x 4 inch outlet boxes. The model number is EST 1504-AQ.

6. Beam Detectors
a. Provide beam detectors with automatic gain control and designed to detect smoke in a large volume. The system will be comprised of three pieces, a transmitter head, a receiver head, and a control box. When the signal strength is reduced to a level between the obscuration threshold and 93% for more than 8 to 10 seconds, the fire alarm output relay is activated. The alarm obscuration threshold may be set at 25%, 35% or 50% obscuration, depending on the application. Reduction in signal strength below 93% is indicated as a fault condition. The model number is EST Fireray 2000.

7. 120VAC Smoke Detectors
a. Provide Gentex 3120F 120 Volt smoke detectors as required in compliance with UL 217, applicable IBC/IFC Standards and NFPA 72. Provide with a 9 VDC alkaline battery for backup in the event building power is lost. The battery impedance shall be verified and the detector shall provide a low or missing battery warning. Provide three position test feature that simulates a 0.85% and 3.5% actual smoke condition in full compliance with NFPA 72 and UL Standards.

b. ?? [FACP Interface] Provide Form A/Form C dry contacts for remote annunciation. Provide interface to FACP.

c. For all rooms indicated by the Architect to be handicap accessible provide a Gentex 7109 CS-W wall mounted 120VAC smoke detector with 9 VDC battery backup with local 90dba piezo and 177 candela strobe with "FIRE" lettering and listed per UL 1971.

B. Control Modules
1. Control Relay Module - SIGA-CR
a. Provide intelligent control relay modules as required. The Control Relay Module shall provide one form “C” dry relay contact rated at 2 amps @ 24 VDC to control external appliances or equipment shutdown. The control relay shall be rated for pilot duty and
releasing systems. The position of the relay contact shall be confirmed by the system firmware. The control relay module shall be suitable for mounting on North American 2 ½" (64mm) deep 1-gang boxes and 1 ½" (38mm) deep 4" square boxes with 1-gang covers.
b. The addressable control relay circuit module shall be an EST model SIGA-CR.

2. Dual Input Module - SIGA-CT2
a. Provide intelligent dual input modules as required. The Dual Input Module shall provide two (2) supervised Class B input circuits each capable of a minimum of 4 personalities, each with a distinct operation. The module shall be suitable for mounting on North American 2 ½" (64mm) deep 2-gang boxes and 1 ½" (38mm) deep 4" square boxes with 2-gang covers, or European 100mm square boxes. The dual input module shall support the following circuit types:
   1) Normally-Open Alarm Latching (Manual Stations, Heat Detectors, etc.)
   2) Normally-Open Alarm Delayed Latching (Waterflow Switches)
   3) Normally-Open Active Non-Latching (Monitor, Fans, Dampers, Doors, etc.)
   4) Normally-Open Active Latching (Supervisory, Tamper Switches)
b. The intelligent dual input module shall be an EST model SIGA-CT2.

3. Dual Input Signal Module - SIGA-CC2
a. Provide intelligent dual input signal modules as required. The Dual Input (Dual Riser Select) Signal Module shall provide a means to selectively connect one of two (2) signaling circuit power risers to one (1) supervised output circuit. The module shall be suitable for mounting on North American 2 ½" (64mm) deep 2-gang boxes and 1 ½" (38mm) deep 4" square boxes with 2-gang covers, or European 100mm square boxes. The dual input signal module shall support the following operation:
   Audible/Visible Signal Power Selector (Polarized 24 Vdc @ 2A, 25 Vrms @ 50w or 70 Vrms @ 35w of Audio).
b. The intelligent dual input signal module shall be an EST model SIGA-CC2.

4. Isolator Module - SIGA-IM
a. Provide intelligent fault isolators modules as required. The Isolator Module shall be capable of isolating and removing a fault from a class A data circuit while allowing the remaining data loop to continue operating. The module shall be suitable for mounting on North American 2 ½" (64mm) deep 2-gang boxes and 1 ½" (38mm) deep 4" square boxes with 2-gang covers, or European 100mm square boxes.
b. The intelligent fault isolator module shall be an EST model SIGA-IM.

5. Monitor Module - SIGA-MM1
a. Provide intelligent monitor modules as required. The Monitor Module shall be factory set to support one (1) supervised Class B Normally-Open Active Non-Latching Monitor circuit. The monitor module shall be suitable for mounting on North American 2 ½" (64mm) deep 1-gang boxes and 1 ½" (38mm) deep 4" square boxes with 1-gang covers.
b. The intelligent monitor module shall be an EST model SIGA-MM1.

6. Single Input Module - SIGA-CT1
a. Provide intelligent single input modules as required. The Single Input Module shall provide one (1) supervised Class B input circuit capable of a minimum of 4 personalities, each with a distinct operation. The module shall be suitable for mounting on North American 2 ½" (64mm) deep 1-gang boxes and 1 ½" (38mm) deep 4" square boxes with 1-gang covers. The single input module shall support the following circuit types:
   1) Normally-Open Alarm Latching (Manual Stations, Heat Detectors, etc.)
   2) Normally-Open Alarm Delayed Latching (Waterflow Switches)
   3) Normally-Open Active Non-Latching (Monitor, Fans, Dampers, Doors, etc.)
   4) Normally-Open Active Latching (Supervisory, Tamper Switches)
b. The intelligent single input module shall be an EST model SIGA-CT1.

7. Single Input Signal Module - SIGA-CC1
a. Provide intelligent single input signal modules as required. The Single Input (Single Riser Select) Signal Module shall provide one (1) supervised Class B output circuit capable of a minimum of 2 personalities, each with a distinct operation. When selected as a telephone power selector, the module shall be capable of generating its own "ring tone".
The module shall be suitable for mounting on North American 2 ½" (64mm) deep 2-gang boxes and 1 ½" (38mm) deep 4" square boxes with 2-gang covers, or European 100mm square boxes. The single input signal module shall support the following operations:

1) Audible/Visible Signal Power Selector (Polarized 24 Vdc @ 2A, 25Vrms @50w or 70 Vrms @ 35 Watts of Audio)

2) Telephone Power Selector with Ring Tone (Fire Fighter's Telephone)

b. The intelligent single input signal module shall be an EST model SIGA-CC1.

8. Universal Class AB Module - SIGA-UM
   a. Provide intelligent class A/B modules as required. The Universal Class A/B Module shall be capable of a minimum of fifteen (15) distinct operations. The module shall be suitable for mounting on North American 2 ½" (64mm) deep 2-gang boxes and 1 ½" (38mm) deep 4" square boxes with 2-gang covers, or European 100mm square boxes. The universal class A/B module shall support the following circuit types:
   1) Two (2) supervised Class B Normally-Open Alarm Latching.
   2) Two (2) supervised Class B Normally-Open Alarm Delayed Latching.
   3) Two (2) supervised Class B Normally-Open Active Non-Latching.
   4) Two (2) supervised Class B Normally-Open Active Latching.
   5) One (1) form "C" dry relay contact rated at 2 amps @ 24 Vdc.
   6) One (1) supervised Class A Normally-Open Alarm Latching.
   7) One (1) supervised Class A Normally-Open Alarm Delayed Latching.
   8) One (1) supervised Class A Normally-Open Active Non-Latching.
   9) One (1) supervised Class A Normally-Open Active Latching.
   10) One (1) supervised Class A 2-wire Smoke Alarm Non-Verified.
   11) One (1) supervised Class B 2-wire Smoke Alarm Non-Verified.
   12) One (1) supervised Class A 2-wire Smoke Alarm Verified
   13) One (1) supervised Class B 2-wire Smoke Alarm Verified
   14) One (1) supervised Class A Signal Circuit, 24Vdc @ 2A.
   15) One (1) supervised Class B Signal Circuit, 24Vdc @ 2A.

b. The intelligent class A/B module shall be an EST model SIGA-UM.

9. Waterflow-Tamper Module - SIGA-WTM
   a. Provide intelligent waterflow/tamper modules as required. The Waterflow/Tamper Module shall be factory set to support two (2) supervised Class B input circuits. Channel A shall support a Normally-Open Alarm Delayed Latching Waterflow Switch circuit. Channel B shall support a Normally-Open Active Latching Tamper Switch. The waterflow/tamper module shall be suitable for mounting on North American 2 ½" (64mm) deep 1-gang boxes and 1 ½" (38mm) deep 4" square boxes with 1-gang covers.

b. The intelligent waterflow/tamper module shall be an EST model SIGA-WTM.

C. Notification Appliances
   1. General (signals)
      a. All appliances, which are supplied, for the requirements of this specification shall be UL Listed for Fire Protective Service, and shall be capable of providing the "equivalent facilitation" which is allowed under the Americans with Disabilities Act Accessibilities Guidelines (ADA(AG)), and shall be UL 1971 Listed.
      b. All appliances shall be of the same manufacturer as the fire alarm control panel specified to insure absolute compatibility between the appliances and the control panels, and to insure that the application of the appliances are done in accordance with the single manufacturer's instructions.
      c. Any appliances that do not meet the above requirements, and are submitted for use must show written proof of their compatibility for the purpose intended. Such proof shall be in the form of documentation from all manufacturers that clearly states that their equipment (as submitted) is 100% compatible with each other for the purpose intended. All strobes shall be provided with lens markings oriented for wall mounting.
      d. All notification appliances shall be white unless noted otherwise on the drawings.

   2. Low Profile Horns

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a. Provide low profile wall mount horns as required. The horn shall provide an 84-dBA sound output at 10 ft. when measured in reverberation room per UL-464. The horn shall have a selectable steady or synchronized temporal output. In and out screw terminals shall be provided for wiring. The horn shall mount in a North American 1-gang box.

b. The low profile wall mount horns shall be EST Genesis series.

3. Low Profile Horn-Strobes
a. Provide low profile wall mount horn/strobes as required. The horn/strobe shall provide an audible output of 84 dBA at 10 ft. when measured in reverberation room per UL-464. Strobes shall provide synchronized flash outputs. The strobe output shall be determined as required by its specific location and application from a family of 15cd, 30cd, 60cd, 75cd & 110cd devices. The horn shall have a selectable steady or synchronized temporal output. In and out screw terminals shall be provided for wiring. Low profile horn/strobes shall mount in a North American 1-gang box.

b. The low profile wall mount horn/strobes shall be EST Genesis series.

4. Low Profile Strobes
a. Provide low profile wall mounted strobes as required. In and out screw terminals shall be provided for wiring. Strobes shall provide synchronized flash outputs. Strobe output shall be determined as required by its specific location and application from a family of 15cd, 30cd, 60cd, 75cd, or 110cd devices. Low profile strobes shall mount in a North American 1-gang box.

b. The low profile wall mounted strobes shall be EST Genesis Series.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General

1. Install system components and all associated devices in accordance with applicable NFPA Standards and manufacturer's recommendations.

2. Installation personnel shall be supervised by persons who are qualified and experienced in the installation, inspection, and testing of fire alarm systems. Examples of qualified personnel shall include, but not be limited to, the following:
   a. Factory trained and certified personnel.
   b. National Institute of Certification in Engineering Technologies (NICET) fire alarm level II certified personnel.

3. Contractor shall be certified by state or local authority.

4. All equipment shall be attached to walls and ceiling/floor assemblies and shall be mounted firmly in place.

5. Detectors shall not be supported solely by suspended ceilings. Fasteners and supports shall be sized to support the required load.

B. Installation Sequence

1. Installation of the systems shall be conducted in stages and phased such that circuits and equipment are installed in the following order:
   a. Riser conduits, AC power conduits and control cabinets.
   b. Fire command center, remote control panel(s), control component(s), annunciator(s), remote CRT terminal(s), and printer(s).
   c. Conduits and wiring for complete notification circuits and appliance installation throughout facility.
   d. Pre-test the audible and visual notification appliance circuits.
   e. Install all new detection devices.
   f. Terminations between field devices and the associated control equipment.
   g. The detection system shall be switched over and end of each day the system shall be
C. Conductors–Open Cable-Raceway

1. The requirement of this section apply to all system conductors, including all signaling line, initiating device, notification appliance, auxiliary function, remote signaling, AC and DC power and grounding/shield drain circuits, and any other wiring installed by the Contractor pursuant to the requirements of these Specifications.

2. All circuits shall be rated power limited in accordance with NEC Article 760.

3. All circuits shall be installed in raceway or plenum rated cable at the discretion of the Engineer.

4. All new system conductors shall be of the type(s) specified herein.

5. All initiating circuit, signaling line circuit, AC power conductors, shield drain conductors and grounding conductors, shall be solid copper, stranded or bunch tinned (bonded) stranded copper.

6. All signaling line circuits, including all addressable initiating device circuits shall be 18 AWG minimum multi-conductor jacketed twisted cable or twisted shielded or as per manufacturer's requirements.

7. All non-addressable initiating device circuits, 24 VDC auxiliary function circuits shall be 18 AWG minimum or per manufacturer's requirements.

8. All notification appliance circuit conductors shall be solid copper or bunch tinned (bonded) stranded copper. Where stranded conductors are utilized, a maximum of 7 strands shall be permitted for No. 16 and No. 18 conductors, and a maximum of 19 strands shall be permitted for No. 14 and larger conductors.

9. All audible notification appliance circuits shall be 14 AWG minimum twisted pairs or twisted pairs shielded or per manufacturer's requirements.

10. All visual notification appliance circuits shall be 14 AWG minimum THHN or twisted pairs or twisted shielded pairs or per manufacturer's requirements.

11. Conductors and Raceway

   a. The contractor shall neatly tie-wrap all field-wiring conductors in the gutter spaces of the control panels and secure the wiring away from all circuit boards and control equipment components. All field-wiring circuits shall be neatly and legibly labeled in the control panel. No wiring except home runs from life safety system circuits and system power supply circuits shall be permitted in the control panel enclosures. No wiring splices shall be permitted in a control panel enclosure.

   b. All penetration of floor slabs and firewalls shall be fire stopped in accordance with all local fire codes.

12. Open Cable

   a. Power-limited cable in accordance with NEC 70, where used, not installed in UL listed metal conduit or raceway shall be mechanically protected by building construction features.

   b. Installation shall be in areas not subjected to mechanical injury.

   c. All circuits shall be supported by the building structure. Cable shall be attached by straps to the building structure at intervals not greater than 10 feet. Wiring installed above drop ceilings, cable shall not be laid on ceiling tiles. Cable shall not be fastened in a manner that puts tension on the cable.

   d. Cable type shall be FPLP, FPLR or FPL, or permitted substitutions, selected for the installation application as required by NEC 70, Section 760-61.

   e. All cable that is not enclosed by conduit shall be supported and anchored with nylon straps or clamps. The use of staples is prohibited.

13. Conduit Raceway

   a. All systems and system components listed to UL864 Control Units for Fire Protective Signaling Systems may be installed within a common conduit raceway system, in
accordance with the manufacturer’s recommendations. System(s) or system components not listed to the UL864 standard shall utilize a separate conduit raceway system for each of the sub-systems.

b. The requirements of this section apply to all system conduits, raceways, electrical enclosures, junction boxes, pull boxes and device back boxes.

c. All system conduits shall be of the sizes and types specified.

d. All system conduits shall be EMT, 3/4 -inch minimum, except for flexible metallic conduit used for whips to devices only, maximum length 6 feet, 3/4-inch diameter, minimum.

e. All system conduits, which are installed in areas, which may be subject to physical damage or weather, shall be IMC or rigid steel, 3/4 -inch minimum.

f. Conduits shall be sized according to the conductors contained therein. Cross sectional area percentage fill for system conduits shall not exceed 40%.

g. Provide all new conduit raceway and conduit riser.

h. All fire alarm conduit systems shall be routed and installed to minimize the potential for physical, mechanical or by fire damage, and so as not to interfere with existing building systems, facilities or equipment, and to facilitate service and minimize maintenance.

i. All conduits, except flexible conduit whips to devices, shall be solidly attached to building structural members, ceiling slabs or permanent walls. Conduits shall not be attached to existing conduit, duct work, cable trays, other ceiling equipment, drop ceiling hangers/grids or partition walls, except where necessary to connect to initiating, notification, or auxiliary function devices.

j. All system conduits, junction boxes, pull boxes, terminal cabinets, electrical enclosures and device back boxes shall be readily accessible for inspection, testing, service and maintenance.

3.02 FIELD QUALITY CONTROL

A. Test & Inspection

1. All intelligent analog addressable devices shall be tested for current address, sensitivity, and user defined message.

2. All wiring shall be tested for continuity, shorts, and grounds before the system is activated.

3. All test equipment, instruments, tools and labor required to conduct the tests shall be made available by the installing contractor.

4. The system including all its sequence of operations shall be demonstrated to the Owner, his representative, and the local fire inspector. In the event the system does not operate properly, the test shall be terminated. Corrections shall be made and the testing procedure shall be repeated until it is acceptable to the Owner, his representatives and the fire inspector.

5. At the final test and inspection, a factory trained representative of the system manufacturer shall demonstrate that the system functions properly in accordance with these specifications. The representative shall provide technical supervision, and participate during all of the testing for the system.

6. All fire alarm testing shall be in accordance with National Fire Alarm Code, NFPA 72 - 1999, Chapter 7.

7. A letter from the Contractor certifying that the system is installed entirely in accordance with the system manufacturer's recommendations and within the limitations of the required listings and approvals, that all system hardware and software has been visually inspected and functionally tested by a manufacturer's certified representative, and that the system is in proper working order.

END OF SECTION 28 31 00
PART 1 – GENERAL

1.01 WORK INCLUDED

A. The work covered by this Section includes furnishing all labor, equipment, and materials required to accomplish all clearing, grubbing, excavation, dewatering, sheeting, backfilling, grading, and any other similar earthwork operation which may be necessary to properly complete the work. All work shall be done in conformity with the Specifications and the directions of the Engineer.

B. This Section includes the following:

1. Preparing and grading subgrades for slabs, walks, pavements and landscaping.
2. Excavating and backfilling for buildings and structures.
3. Drainage and moisture-control fill course for slabs-on-grade.
4. Subbase course for walks and pavements.
5. Subsurface drainage backfill for walls and trenches.
6. Excavating and backfilling trenches within building lines.
7. Excavating and backfilling for underground mechanical and electrical utilities and appurtenances.

1.02 RELATED DOCUMENTS

A. Division 1: General Requirements.

B. Division 2: Site Work.

1.03 DEFINITIONS

A. Excavation: Consists of the removal of material encountered to subgrade elevations and the reuse or disposal of materials removed.

B. Subgrade: The uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

C. Borrow: Soil material obtained off-site when sufficient approved soil material is not available from excavations.

D. Subbase Course: The layer placed between the subgrade and base course in a paving system or the layer placed between the subgrade and surface of a pavement or walk.
E. Base Course: The layer placed between the subbase and surface pavement in a paving system.

F. Drainage Fill: Course of washed granular material supporting slab-on-grade placed to cut off upward capillary flow of pore water.

G. Unauthorized Excavation: Consists of removing materials beyond indicated subgrade elevations or dimensions without direction by the Engineer. Unauthorized excavation, as well as remedial work directed by the Engineer, shall be at the Contractor's expense.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below ground surface.

I. Utilities: On-site underground pipes, conduits, ducts and cables, as well as underground services within building lines.

1.04 SUBMITTALS

A. General: Submit the following according Division 1 Submittals of the Specifications.

B. Product data for the following:
   1. Each type of plastic warning tape.

C. Samples of the following:
   1. 20-lb samples sealed in airtight containers, of each proposed fill and backfill soil material from on-site or borrow sources.
   2. 12-by-12-inch sample of filter fabric.
   3. 12-by-12-inch sample of ground stabilization fabric.

D. Test Reports: In addition to test reports required under field quality control, submit the following:
   1. Laboratory analysis of each soil material proposed for fill and backfill from on-site and borrow sources.
   2. One optimum moisture-maximum density curve for each soil material.
   3. Report of field density test of each stratum tested.

1.05 SUMMARY

A. The elevations shown on the Drawings as existing are taken from the best existing data and are intended to give reasonable, accurate information about the existing elevations. They may not be exact, and the Contractor must satisfy himself as to the exact quantities of excavation and fill required.
B. Earthwork operations shall be performed in a safe and proper manner with appropriate precautions being taken against all hazards.

C. All excavated and filled areas for structures, trenches, fills, topsoil areas, embankments and channels shall be maintained by the Contractor in good condition at all times until final acceptance by the Owner. All damage caused by erosion or other construction operations shall be repaired by the Contractor using material of the same type as the damaged material.

D. Earthwork within the public rights-of-way shall be done in accordance with requirements and provisions of the permits issued by applicable agencies for the construction within their respective rights-of-way. Such requirements and provisions, where applicable, shall take precedence and supersede the provisions of these Specifications.

E. The Contractor shall control grading in a manner to prevent water running into excavations. Obstruction of surface drainage shall be avoided and means shall be provided whereby storm water can be uninterrupted in existing gutters, other surface drains, or temporary drains. Free access must be provided to all fire hydrants, valves, and meters.

F. No classification of excavated materials will be made. Excavation work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the contract work, regardless of the type, character, composition, or condition thereof.

G. Tests for compaction and density shall be conducted by the Engineer or by an independent testing laboratory selected by him. Costs of compaction tests performed by an independent testing laboratory shall be paid for by the Contractor. The Contractor shall make all necessary excavations and shall supply any samples of materials necessary for conducting compaction and density tests. The cost of all retests made necessary by the failure of materials to conform to the requirements of these Contract Documents shall be paid by the Contractor.

H. All earthwork operations shall comply with the requirements of OSHA Construction Standards, Part 1926, Subpart P, Excavations, Trenching, and Shoring, and Subpart O, Motor Vehicles, Mechanized Equipment, and Marine Operations, and shall be conducted in a manner acceptable to the Owner and the Engineer.

I. It is understood and agreed that the Contractor has made a thorough investigation of the surface and subsurface conditions of the site and any special construction problems which might arise as a result of nearby watercourses and floodplains, particularly in areas where construction activities may encounter water-bearing sands and gravels or limestone solution channels. The Contractor shall be responsible for providing all services, labor, equipment, and materials necessary or convenient to him for completing the work within the time specified in these Contract Documents.

1.06 QUALITY ASSURANCE

A. The Contractor shall perform earthwork in compliance with the requirements of all authorities having jurisdiction over the construction.

B. Testing and Inspection Service: The Engineer or a qualified independent geotechnical engineering testing agency, designated by the Engineer, will be employed to classify proposed on-site and borrow soils to verify that soils comply with specified requirements and to perform required field and laboratory testing.
C. Pre-installation Conference: The Contractor will conduct a conference at Project site to comply with requirements of Division 1, Section 01200, Project Meetings.

1. Before commencing earthwork, the Contractor will meet with representatives of the governing authorities, Owner, Engineer, consultants, Geotechnical Engineer, independent testing agency and other concerned entities. The Contractor will review earthwork procedures and responsibilities including testing and inspection procedures and requirements. The Contractor shall notify participants at least 3 working days prior to convening conference. The Contractor shall record discussions and agreements and furnish a copy to each participant.

1.07 PROJECT CONDITIONS

A. Existing Utilities: The Contractor shall not interrupt existing utilities serving facilities occupied by the Owner or others except when permitted in writing by the Engineer and then only after acceptable temporary utility services have been provided.

1. The Contractor shall provide a minimum 48-hours written notice to the Engineer and receive written notice to proceed before interrupting any utility.

B. The Contractor shall demolish and completely remove from site existing underground utilities indicated on the plans to be removed. The Contractor shall coordinate with utility companies to shutoff services if lines are active.

PART 2 – PRODUCTS

2.01 SOIL MATERIALS

A. The Contractor shall provide approved borrow soil materials from off-site when sufficient approved soil materials are not available from excavations.

B. Satisfactory Soil Materials are defined as ASTM D 2487 soil classification groups GW, GP, GM, SW, SP, SM, ML and CL; free of rock or gravel larger than 2 inches in any dimension, debris, waste, frozen materials, vegetation and other deleterious matter.

C. Unsatisfactory Soil Materials are defined as ASTM D 2487 soil classification groups GC, SC, MH, CH, OL, OH and PT.

D. Backfill and Fill Materials shall be satisfactory soil materials.

E. Engineered fill is defined as subbase or base materials.

2.02 ACCESSORIES

A. Detectable Warning Tape shall be acid and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick minimum, 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 2'-6" deep.
1. Tape Colors: Provide tape colors to utilities as follows:
   b. Yellow: Gas, oil, steam and dangerous materials.
   c. Orange: Telephone and other communications.
   d. Blue: Water systems.
   e. Green: Sewer systems.

B. The Contractor shall install a continuous run of plastic metallic tape above the top of the pipe at 18 to 24 inches below finished grade. Tape shall be suitable for detection with metal pipe location equipment, labeled to identify contents of pipe, and brightly colored to contrast with the soil. In addition to the tape, the contractor shall install a continuous run of tracer wire attached to pipe runs greater than 500’. This tracer wire shall be attached to a 2” galvanized pipe with a 180 degree bend at top extending 36” above grade for connection to locator equipment.

C. Fabric:

1. Filter Fabric (for underdrains and other drainage use) shall be a non-woven pervious geotextile fabric that meets the following requirements:
   a. Weight (ASTM D-3776): 4.5 ounces per square yard.
   c. Grab Tensile Strength (ASTM D-1682): 120 pounds.
   d. Grab Elongation (ASTM D-1682): 55%.
   e. Flow Rate (CFMC-GET-2): 285 gallons per minute per square foot.

PART 3 – EXECUTION

3.01 PREPARATION

A. The Contractor shall protect structures, utilities, sidewalks, pavements and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.

B. The Contractor shall protect subgrades and foundation soils against freezing temperatures or frost and provide protective insulating materials as necessary.

C. The Contractor shall provide erosion control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.02 DRAINAGE

A. The Contractor shall provide positive drainage on site at all times and prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades and from flooding Project site and surrounding area.

B. The Contractor shall protect subgrades and foundation soils from softening and damage by rain or water accumulation.
3.03 EXCAVATION

A. The Contractor shall perform all excavation of every description, and of whatever substances encountered, to the dimensions and levels shown on the Drawings and/or specified.

B. Over excavation of the organic sand layer (i.e. small to large roots) shall be performed. The preliminary soils investigation report shall be made available at the contractors. The over excavation operations shall be monitored by a licensed geotechnical engineer to evaluate the horizontal and vertical extent of the organic zone. The geotechnical engineer shall certify that (1) all organics are removed; and (2) excavation of acceptable soils has been minimized. The over excavation shall be performed within and to a distance of at least five feet beyond each individual structure footprint.

C. After the organics are removed, compacted of the resulting subgrade should not be attempted. Dry structural fill, as approved by the engineer, shall be placed over the subgrade with relatively light tracked equipment. No rubber tired equipment should be allowed to traverse the areas until at least two and a half feet of compacted structural fill is in place. The structural fill, after placement and compaction, should have densities equivalent to 95 percent of the Modified Proctor maximum dry density (ASTM D 1557) design grade elevations.

D. Unclassified Excavation: Excavation is unclassified and includes excavation to required subgrade elevations regardless of the character of materials and obstructions encountered.

1. Rock excavating equipment for footings, trenches and pits shall be equivalent to Caterpillar Model No. 215D LC track-mounted hydraulic excavator, equipped with a 42-inch-wide short-tip radius rock bucket, rated at not less than 120-hp flywheel power with bucket-curling force of not less than 25,000 lbs. and stick-crowd force of not less than 18,700 lbs., measured according to SAE Standard J1179.

2. Rock-excavating equipment for open excavations shall be equivalent to Caterpillar Model No. 973, heavy-duty, track-mounted loader, rated at not less than 210-hp flywheel power and developing minimum of 45,000-lb breakout force, measured according to SAE Standard J732c-69. Excavations more than 10 feet in width and pits more than 30 feet in either length or width are defined as open excavations.

E. Rock will not be classified as such for additional payment. The Bidder shall satisfy himself as to rock and other materials which may be encountered in excavation, and make proper allowances for all contingencies in his lump sum or unit price bid. Neither the Owner nor the Engineer will be responsible for subsurface conditions found.

F. Excavation for pipelines shall be made in open cut unless shown otherwise on the Drawings. Trenches shall be cut true to the lines and grades shown on the Drawings or established by the Engineer on the ground. The banks of trenches shall be cut in vertical parallel planes equidistant from the pipe centerline. From an elevation 12 inches above the top of the pipe to the bottom of the trench, the horizontal distance between vertical planes for different sizes of pipe shall not exceed those specified and/or shown on the Drawings. When sheeting is used, the width of the trench shall be considered as the distance between the inside faces of the sheeting. The bottom of the trench shall be cut carefully to the required grade of the pipe except where bedding materials or cradles are required, in which case the excavation shall extend to the bottom of the bedding or cradles as shown on the Drawings. Minimum pipe cover shall be as specified or shown on the Drawings.
1. Bell holes for bell and spigot pipe and mechanical joint pipe shall be excavated at proper intervals so the barrel of the pipe will rest for its entire length upon the bottom of the trench. Bell holes shall be large enough to permit proper installation of all joints in the pipe. Bell holes shall not be excavated more than 10 joints ahead of pipe laying. No part of any bell or coupling shall be in contact with the trench bottom, trench walls, or granular embedment when the pipe is jointed.

2. Pipe trenches shall not be excavated more than 100 feet in advance of pipe laying and all work shall be performed to cause the least possible inconvenience to the public. Adequate temporary bridges or crossings shall be constructed and maintained where required to permit uninterrupted vehicular and pedestrian traffic.

3. Unless otherwise specified herein or shown on the Drawings, wherever pipe trenches are excavated below the elevation shown on the Drawings, the Contractor, at his own expense, shall fill the void thus made to the proper grade with Class "C" concrete or with compacted layers of crushed rock or gravel conforming to the requirements for bedding materials.

4. Rock, boulders and large stones encountered in trenches shall be removed to provide a clearance of not less than 6 inches in every direction from all parts of pipe, fittings, and other appurtenances.

5. In all cases where materials are deposited along open trenches they shall be placed so that no damage will result to the work or adjacent property in case of rain or other surface wash.

G. If additional material, other than that to be obtained from excavation, is required for backfilling and grading, the Contractor shall obtain that additional material from borrow as directed by the Engineer.

H. All excess excavated earth, and all excavated rock, shall be hauled off to a designated spoil area. Surfaces and slopes of spoil areas shall be left smooth and free to drain.

I. All ditches are to be closed at the end of each work day.

3.04 STABILITY OF EXCAVATIONS

A. Contractor must comply with all local codes, ordinances and requirements of authorities having jurisdiction to maintain stable excavations.

B. The sides of all excavations shall be sufficiently sheeted, shored, and braced whenever necessary to prevent slides, cave-ins, settlement, or movement of the banks and to maintain the excavation clear of all obstructions. Wood or steel sheeting of approved design and type shall be used in wet, saturated, or flowing ground. All sheeting, shoring, and bracing shall have sufficient strength and rigidity to withstand the pressures exerted.

C. The responsibility for correctly assessing the need for sheeting and analyzing the stresses induced shall be the total responsibility of the Contractor. Since the Engineer does not dictate or determine the Contractor's sequence or limits of excavation, the Engineer assumes no responsibility for sheeting and shoring. The Contractor must employ or otherwise provide for adequate professional structural and geotechnical engineering supervision to assess the need for sheeting and shoring and design same. Results of sheeting and shoring analysis and design shall be submitted to the Engineer upon request.
D. Excavations adjacent to existing or proposed buildings and structures, or in paved streets or alleys shall be sheeted, shored, and braced adequately to prevent undermining beneath or subsequent settlement of such structures or pavements. Underpinning of adjacent structures shall be done when necessary to maintain structures in safe condition. Any damage to structures or pavements occurring through settlements, water or earth pressures, slides, caves, or other causes; due to failure or lack of sheeting or bracing, or due to improper bracing; or occurring through negligence or fault of the Contractor in any other manner shall be repaired by the Contractor at his own expense.

E. Sheetin, shoring, or bracing materials shall not be left in place unless otherwise specified or shown on the Drawings or ordered by the Engineer in writing. Such materials shall be removed in such manner that no danger or damage will occur to new or existing structures or property, public or private, and so that cave-ins or slides will not take place. Steel sheeting may be removed without cutting, provided the rate of removal is in pace with tamping and backfilling operations to assure complete filling of the void created by the withdrawal of the sheeting. Complete withdrawal of the sheeting in advance of tamping and backfilling will not be permitted.

F. All holes and voids left in the work by the removal of sheeting, shoring, or bracing shall be filled and thoroughly compacted.

3.05 UNAUTHORIZED EXCAVATION

A. The Contractor shall not commence or continue any excavation until authorized by the Engineer.

B. The Contractor shall fill any unauthorized excavation as directed by the Engineer.

3.06 STORAGE OF SOIL MATERIALS

A. The Contractor shall stockpile excavated materials acceptable for backfill and fill soil materials, including acceptable borrow materials.

B. The Contractor shall stockpile soil materials without intermixing.

C. The Contractor shall place, grade and shape stockpiles to drain surface water.

D. The Contractor shall cover to prevent wind-blown dust.

E. The Contractor shall stockpile soil materials away from edge of excavations.

F. The Contractor shall not store soil materials within drip line of remaining trees.

3.07 BACKFILLING

A. The backfilling of sewer and pipe line trenches shall be started immediately after the construction of same has been inspected by the Engineer. Selected backfill material shall consist of finely divided earth, stone, dust, sand, crushed stone, or other approved material free from all wood, vegetable matter, debris, and other objectionable material and having scattered clods, stone or broken concrete less than 2 inches in maximum dimension.
1. Material that is too dry to be adequately compacted shall receive a prior admix of sufficient water to obtain optimum moisture content. Material having excessive water content shall not be placed at any time.

2. Selected backfill material shall be carefully placed in the trench on each side of the pipe in 6-inch layers for the full width of the trench and thoroughly and uniformly compacted by tamping or ramming. Sufficient select backfill material shall be placed around the pipe and compacted to provide not less than 12 inches cover over the top of the pipe.

3. Backfilling shall be carried on simultaneously on both sides of the pipe and in a manner which will prevent injurious side pressures. If suitable select materials are not available from the trench excavation, the Contractor will be required to obtain the select materials elsewhere.

B. Across sidewalks and driveways and at any other places subject to vehicular traffic or other superimposed loads, trench backfill shall be compacted in 6 inch layers to the density of the original adjacent material for the full depth of the trench. The top 6 inches of backfill shall consist of uniformly graded crushed stone.

C. Roadway subgrade shall be accomplished in layers not exceeding 6 inches in depth and each layer shall be thoroughly compacted to minimum 98 percent of the Modified Proctor maximum dry density as determined by ASTM D-698. This operation shall include any reshaping and wetting required to obtain proper compaction. All soft or otherwise unsuitable material shall be removed and replaced with suitable material.

D. In all other areas not affected by superimposed loads, trench backfill may be placed from the level 12 inches above the top of pipe upward without compaction. At these places backfill shall be neatly rounded over the trench to sufficient height to allow for settlement to grade after consolidation.

E. Wherever the subgrade is by nature too soft or mucky, in the opinion of the Engineer, for the proper installation of the pipe, he may order the Contractor to undercut the trench and backfill with stone or gravel bedding material. The stone shall be brought to the subgrade required by the class of bedding for the particular location and compacted.

F. Where slabs are to be constructed on earth fill, the fill shall be of select material. Selected backfill material shall consist of finely divided earth, stone, dust, sand, crushed stone, or other approved material free from all wood, vegetable matter, debris, and other objectionable material and having scattered clods, stone or broken concrete less than 2 inches in maximum dimension. The fill shall be placed in layers of not more than six inches compacted thickness and compacted by the use of heavy rolling or power tamping equipment to secure at least 95% of the Modified Proctor Dry Density.

G. Backfills around structures shall be properly placed and compacted. The fills shall be brought up in layers. The layers shall be thoroughly compacted to at least 95% of the Modified Proctor Dry Density, each layer to be not deeper than six inches compacted thickness. Compaction around structures shall be by use of heavy power tamping equipment.

3.08 STORM DRAIN TRENCH BACKFILL

A. The Contractor shall shape bedding course to provide continuous support for bells, joints and barrels of storm drain pipe.
B. After the trench bottom has been exposed and before placement of any backfill, the trench bottom shall be inspected by the Engineer.

C. A minimum 12-inch depth course of No. 57 stone wrapped in filter fabric shall be placed in the bottom of the trench. None of the aggregate in this 12-inch course shall be in contact with soil. The filter fabric shall be lapped a minimum of two (2) feet at the joints.

D. Aggregate backfill shall be placed in 8-inch layers on top of the filter fabric wrapped 12-inch course. The first 8-inch layer shall be consolidated to a uniform density. Each subsequent 8-inch layer of aggregate backfill shall be placed and consolidated to a uniform density. Care shall be exercised in the placement of each layer to see that each section is continuously supported throughout its length. Aggregate shall be so placed up to one-half (½) the outside diameter of the pipes.

E. The trench above one-half (½) the outside diameter of the pipes shall be backfilled with material meeting the requirements of Section 207 of the above-cited standard specification for normal backfill. The material shall be placed in 6-inch layers and compacted to 95 percent of the laboratory dry density except that the 12 inches immediately underneath the stone base shall be compacted to 100 percent of the laboratory dry density.

F. Compaction tests shall be performed on each 6-inch layer of normal backfill between and alongside each 60-inch pipe at intervals not exceeding 200 feet. The next layer shall not be placed until the specified compaction has been achieved in each underlying layer.

3.09 MOISTURE CONTROL

A. The site shall be kept free of surface water at all times. The Contractor shall install drainage ditches and dikes and shall perform all pumping and other work necessary to divert or remove rainfall and other accumulations of surface water from the excavations. The diversion and removal of surface water shall be performed in a manner that will prevent the accumulation of water within the construction area where it may be detrimental.

B. Where groundwater is encountered, the Contractor shall make the effort necessary to secure a dry excavation. In sandy and in other suitable type soils, dewatering shall be done by well pointing. If, in the opinion of the Engineer, the Contractor has failed to obtain an absolutely dry excavation by insufficient use of all known methods of dewatering, the Engineer may order the Contractor to excavate below grade and place not less than 6 inches of graded crushed stone fill material over the bottom to form french drains to suitably located sumps and to remove the water by bailing or pumping. The graded crushed stone fill material shall be placed at the Contractor's own expense and shall be of such depth that there shall be no water in the excavation at the time of pouring concrete. All costs of equipment, labor, and materials required for dewatering shall be included in the bid price.

3.10 FIELD QUALITY CONTROL

A. The Contractor shall inspect and test each subgrade and each fill or backfill layer. Do not proceed until test results for previously completed work verify compliance with requirements.

1. Perform field in-place density tests according to ASTM D 1556 (sand cone method), ASTM D 2167 (rubber balloon method), or ASTM D 2937 (drive cylinder method), as
applicable.

a. Field in-place density tests may also be performed by the nuclear method according to ASTM D 2922, provided that calibration curves are periodically checked and adjusted to correlate to tests performed using ASTM D 1556. With each density calibration check, check the calibration curves furnished with the moisture gages according to ASTM D 3017.

b. When field in-place density tests are performed using nuclear methods, make calibration checks of both density and moisture gages at beginning of work, on each different type of material encountered and at intervals as directed by the Engineer.

2. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, perform at least one field in-place density test for every 2,000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.

3. Foundation Wall Backfill: In each compacted backfill layer, perform at least one field in-place density test for each 100 feet or less of wall length, but no fewer than two tests along a wall face.

4. Trench Backfill: In each compacted initial and final backfill layer, perform at least one field in-place density test for each 150 feet or less of trench, but no fewer than two tests.

B. When the tests indicate that subgrades, fills or backfills are below specified density, the Contractor shall scarify and moisten or aerate, or remove and replace soil to the depth required, recompact and retest until required density is obtained.

3.11 PROTECTION AND MAINTENANCE

A. The Contractor shall protect newly graded areas from traffic, freezing, erosion, trash and debris.

B. The Contractor shall repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or lose compaction due to subsequent construction operations or weather conditions.

C. The Contractor shall scarify or remove and replace material to depth directed by the Engineer. The Contractor shall reshape and recompact at optimum moisture content to the required density.

D. Where settling occurs during the Project correction period, the Contractor shall remove finished surfacing, backfill with additional approved material, compact and reconstruct surfacing.

E. The Contractor shall restore appearance, quality and condition of finished surfacing to match adjacent work and eliminate evidence of restoration to the greatest extent possible.

3.12 DISPOSAL OF WASTE AND UNSUITABLE MATERIALS
A. All materials removed by excavation, which are suitable for the purpose, shall be used to the extent possible for backfilling pipe trenches, foundations, and footings and for making embankment fills or for such other purposes as may be shown on the Drawings. All materials not used for such purposes shall be considered as waste materials and the disposal thereof shall be made by the Contractor in a manner and at locations approved by the Engineer.

B. Waste materials shall be spread in uniform layers and neatly leveled and shaped. Spoil banks shall be provided with sufficient and adequate openings to permit surface drainage of adjacent lands.

C. Unsuitable materials, consisting of wood, vegetable matter, debris, soft or spongy clay, peat, and other objectionable material so designated by the Engineer shall be removed from the work site and disposed of by the Contractor in a manner and at a location approved by the Engineer.

D. No unsuitable or waste material shall be dumped on private property unless written permission is furnished by the owner of the property and unless a dumping permit is issued from the local jurisdiction.

3.13 FINAL GRADING

A. After other earthwork operations have been completed, the sites of all structures, roads, and embankments shall be graded within the limits and to the elevations shown on the Drawings. Grading operations shall be so conducted that materials shall not be removed or loosened beyond the required limits. The finished surfaces shall be left in smooth and uniform planes such as are normally obtainable from the use of hand tools. If the Contractor is able to obtain the required degree of evenness by means of mechanical equipment he will not be required to use hand labor methods. Slopes and ditches shall be neatly trimmed and finished to slopes shown on the Drawings unless otherwise approved by the Engineer.

B. Unless otherwise specified or shown on the Drawings, all finished ground surfaces shall be graded and dressed to present a surface varying not more than plus or minus 0.10 foot as regards local humps or depressions and shall be acceptable to the Engineer.

3.14 TOPSOIL

A. All areas to be sprigged or planted with trees, shrubs, or grass as shown on the plans shall be prepared by grading to a smooth, even surface to a level 4 inches below the elevation of the finished grade shown on the Drawings. It shall then be brought to a neat and finished grade by the addition of 4 inches of approved topsoil.

B. Topsoil removed from the construction area may be stockpiled and reused or topsoil may be obtained from approved borrow areas. If obtained from borrow areas, the Contractor shall make suitable arrangements with the property owner and shall pay all costs incident to the borrowed material including royalties.

3.15 SETTLEMENT

A. The Contractor shall be responsible for all settlement of backfill, fills, and embankments which may occur within one (1) year after final acceptance of the work by the Owner.
B. The Contractor shall make, or cause to be made, all repairs or replacements made necessary by settlement within 30 days after receipt of written notice from the Engineer or Owner.
SECTION 31 23 00
EXCAVATION, BACKFILL, FILL AND GRADING FOR STRUCTURES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals necessary to perform all excavation, backfill, fill, grading for structures, and finish grading in preparation for landscaping and grassing, required to complete the work shown and specified. The work shall include, but not necessarily be limited to: excavation for structures, footings, all backfilling and fill; embankment and grading for structures; disposal of waste and surplus materials; and all related work such as sheeting, bracing and pumping.

B. Topsoil, if any, excavated under this Section may be salvaged for convenience for use as necessary for landscaping.

1.02 RELATED WORK

A. Division 31: Site Preparation

B. Division 31: Excavation Backfill, Fill & Grading for Pipe

1.03 QUALITY ASSURANCE

A. Provide services of a registered engineer or land surveyor to lay out site.

B. Establish and maintain bench marks on the site for reference. All vertical dimensions shall be checked from these bench marks.

C. Finished grades, as used herein, mean the required final grade elevations indicated on the drawings. Should finished grades shown on spot elevations conflict with those shown by the contours the spot elevations shall govern.

D. Soil moisture during fill placement should be maintained within four percent (4%) of the optimum value determined by ASTM D 698 for general area and structural fill and within two percent (2%) of optimum for wall and backfill.

E. All fill areas and areas at grade shall be proof-rolled with a fully loaded tri-axle dump truck or a 20-ton roller to detect any soft areas. Any areas which pump or rut excessively and cannot be densified by continued rolling shall be undercut.

1.04 JOB CONDITIONS

A. Consider the Limits of Work indicated to make determination of the amount of grading. Limit grading to the work as shown and do not disturb the existing terrain or trees outside this work.

B. Subsurface soil data: Subsurface investigation to be performed by Geotechnical Engineer. However, neither Architect, nor Owner assumes responsibility for
completeness or accuracy of data contained therein and no claims for extra compensation or extension of time will be considered based on assumptions.

C. Items of historic or archaeological value discovered during earthwork operations shall remain property of the Owner.

1.05 PROTECTION

A. Lateral Support of Excavation for Structures: Furnish, put in place, and maintain sheeting and bracing required to support the sides of the excavations, to prevent any movement which could in any way diminish the width of the excavation below that necessary for proper construction, and to protect streets and utilities from damage due to lateral movement or settlement of ground.

B. Control of Groundwater Level:

1. Maintain the groundwater level below subgrade of the structure until the concrete structures are up high enough to prevent flooding the structure. Support shall be maintained at both bottom and top levels of wall to prevent flotation.

2. After the structure has been completed in its entirety, backfill as described hereinafter.

3. Flotation shall be prevented by maintaining a positive and continuous operation of the dewatering system. The responsibility and liability for all damages which may result from failure of this system shall be included in the work of this Section.

4. Disposal of drainage water shall be in an area approved by the Owner. Precautions shall be taken to prevent the flow or seepage of drainage back into the drainage area. Particular care shall be taken to prevent the discharge of unsuitable drainage to a water supply or surface water body.

5. Removal of dewatering system shall be accomplished after the dewatering system is no longer required; the material and equipment constitute the system.

1.06 TESTING

A. Soil testing shall be performed by an independent testing agency selected and paid by the Owner.

B. Testing agency shall perform the following testing:

1. Compaction tests in accord with ASTM D698-78.

2. Field density tests for each 2'-0" lift, in accord with ASTM D2937-76 one test for each 10,000 sq. ft. of fill. One test is to be conducted for at least every 500 cubic feet of fill in trenches or restricted area fills.

3. Inspection and testing subgrades and proposed fill materials.

4. Examination of foundation excavations to determine if required soil bearing has been achieved.
5. Examination of excavations to determine that required rock has been removed prior to fill placing and compacting.

6. Verification of unsuitable soil materials to be removed, where classified excavation is indicated.

C. Duties relative to testing include:

1. Provide representative fill soil samples to testing agency for test purposes. Provide 50 lb. of samples of each fill soil.

2. Advise testing agency sufficiently in advance of operations to allow for completion of quality tests and for assignment of personnel.

D. The responsibility for paying costs of additional testing beyond scope of that required and for retesting if initial test reveals nonconformance with specified requirements shall be included as part of the work in this Section.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Structural Fill:

1. Compacted granular fill which will provide support for building or structure foundations will be referred to as structural fill. Backfill which is placed against the exterior side of the building walls or as fill over pipe lines will be referred to as common fill.

2. The soil subgrade immediately beneath pavements and floor slabs should be compacted to at least 98% in the upper 18" of fill areas and the upper 12" of cut areas if they become disturbed during construction.

3. Materials for compacted granular fill shall be gravel, sandy gravel, or gravelly sand free of organic material, loam, wood, trash, and other objectionable material and shall be will graded within the following limits:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Finer by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>6&quot;</td>
<td>100</td>
</tr>
<tr>
<td>No. 4</td>
<td>20-95</td>
</tr>
<tr>
<td>No. 40</td>
<td>0-60</td>
</tr>
<tr>
<td>No. 200</td>
<td>0-8</td>
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</tbody>
</table>

4. Fill soils should be non-expansive material with a plasticity index of less than 30, a liquid limit of less than 50 and a maximum dry density (standard proctor ASTM D 698) of at least 90 pcf. Soil classifications GM, GC, SW, SP, SM, SC, ML, and CL will be allowed provided they meet the above criteria.

B. Common Fill: Mineral soil, substantially free of clay, organic material, loam, wood, trash, or other objectionable material which may be compressible or which cannot be properly compacted. Common fill shall not contain stones larger than 10" (6" max. for within 2'-0" of roadway surface) in any dimension. Common fill shall not contain broken concrete, masonry, rubble, asphalt pavement or other similar materials. It shall have physical properties such that it can be readily spread and compacted during filling.
C. Except as noted in the following paragraph, material used below subgrade within the limits of support of structures shall consist of lean concrete or material meeting the requirements for structural fill as defined above. Crushed stone of #57 size or finer may be used.

D. Where excavation occurs in rock, the working mat shall consist of a lean concrete placed directly on firm rock after all loose rock has been removed.

PART 3 - EXECUTION

3.01 EXCAVATION BELOW GRADE

A. If the bottom of any excavation is taken out below the limits indicated or specified, it shall be refilled with concrete or 6” layers of compacted structural fill.

B. If the subgrade surface is not cared for through failure to postpone final excavation immediately above the subgrade until shortly before placing of the new work thereon, or other failure, or neglect to conduct the excavation work properly so that the surface of the subgrade is in proper condition when ready for construction, remove the unsuitable material and replace it with concrete or compacted structural fill.

3.02 STRUCTURE EXCAVATION AND COMPACTION PROCEDURES

A. Excavation shall be made to such widths as will give suitable room for construction of the structures, for bracing and supporting, pumping and draining; and the bottom of the excavations shall be rendered firm and dry in all respects.

B. Excavation and dewatering shall be accomplished by methods which preserve the undisturbed state of subgrade soils. Subgrade soils which become soft, loose, quick, or otherwise unsatisfactory for support of structures as a result of inadequate excavation, dewatering or other construction methods shall be removed and replaced by structural fill.

C. Dewatering shall be such as to prevent boiling or detrimental saturation at the base of the excavation as specified herein. Install such means as required to preserve the stability of the base of the operation.

D. Excavating equipment shall be satisfactory for carrying out the work in accordance with the Specification. In no case shall earth be plowed, scraped, or dug with machinery so near to the finished subgrade as to result in excavation of, or disturbance of material below grade.

E. During final excavation to subgrade level, take whatever precautions are required to prevent disturbance and remolding of the subgrade. Material which has become softened and mixed with water shall be removed. Hand excavation of the final 3” to 6” will be required as necessary to obtain a satisfactory undisturbed bottom.

F. When excavation for foundations has reached prescribed depths, the Owner’s Representative shall be notified, and he will inspect conditions.

G. The fill shall be placed in layers having a maximum thickness of 8” measured before compaction. Each layer of fill shall be compacted to at least 95% of maximum dry density determined by ASTM Compaction Test, Designation D 698.
H. Large compaction equipment should operate no closer than 5' from backfilled wall.

3.05 COMPACTION

A. Compaction shall be performed as specified hereinafter for the particular materials and operations.

1. Self-propelled compactors shall make compaction passes at a speed of approximately 5 miles per hour.

2. Areas adjacent to structures, and other areas inaccessible to a roller, shall be compacted with hand operated mechanical compaction equipment. Compaction of the fill by such means shall be to the same degree of compaction as obtained by other approved equipment, and the Owner may make the necessary tests to determine the amount of compactive effort necessary to obtain equal compaction. Unless such tests indicated that modifications may be made, the fill compacted by mechanical compactors shall be placed in 6" layers and thoroughly tamped over the entire surface. Compaction equipment is subject to approval by the Owner.

B. Compacted structural fill for structural foundations shall be placed in layers not to exceed 8" thickness by loose measure and shall be compacted to at least 95% of maximum dry density as determined by ASTM Test Designation D 698. The upper one foot of material in fill or at grade areas or cut surfaces should be scarified and compacted to a 98% criteria.

C. The surface of filled areas shall be graded to smooth, true lines, strictly conforming to grades indicated, and no soft spots or uncompacted areas will be allowed in the work.

D. Temporary bracing shall be provided as required during filling and backfilling of all structures to protect partially completed structures against all construction equipment loads, hydraulic pressures and earth pressures.

3.06 BACKFILLING - COMMON FILL

A. Common fill may be used as backfill against the exterior walls of the structures. Material conforming to the requirements of common fill shall be placed in layers having a maximum thickness of 8" measured before compaction.

B. Common fill shall be compacted to at least 95% of maximum density as determined by ASTM compaction tests, Designation D 698.

C. Materials placed in fill areas shall be deposited to the lines and grades shown making due allowance for settlement of the material and for the placing of topsoil thereon.

D. The surfaces of filled areas shall be graded to smooth, true lines, strictly conforming to grades indicated on the paving and grading drawings, and no soft spots or uncompacted areas will be allowed in the work.

E. No compacting shall be done when the material is too wet either from rain or from excess application of water. At such times, work shall be suspended until the previously placed and new materials have dried sufficiently to permit proper compaction.

3.07 EARTH EMBANKMENTS
A. All organic materials, including peat and loam, shall be removed from areas beneath new embankments. If the subgrade slopes are excessive, the subgrade shall be stepped to produce a stable surface for the placement of the embankments. The natural subgrade shall then be compacted by mechanical compaction equipment. The prepared subgrade shall be inspected and approved by the Owner's Representative prior to the placement of structural fill.

B. Fill shall be placed in layers 8" thick measured before compaction. Each layer shall be compacted to at least 95% of the maximum dry density as determined by the ASTM compaction test, Designation D-698.

C. Existing slopes shall be reconstructed as shown.

3.08 DISPOSAL OF UNSUITABLE AND SURPLUS MATERIAL

A. Unsuitable excavated materials and pavement shall become the property of the Contractor and removed and disposed of by him off the project site.

B. Suitable excavated material may be used for fill or backfill if it meets the specifications for common fill and is approved by the Owner's Representative. Excavated material so approved may be neatly stockpiled at the site. If space limitations do not permit stockpiling on the site, the Contractor will be required to make arrangements for off-site stockpiling. Transport of such material from and to the immediate site, including any stockpiling agreements, shall be entirely at the Contractor's expense and shall not constitute grounds for additional payment.

C. Surplus excavated material shall be used to fill depressions or for other purposes as the Owner may direct; otherwise, it shall become the property of the Contractor and shall be removed and disposed of by the Contractor off the project site.

3.09 GRADING

A. Grading in preparation for placing of topsoil, planting areas, paved walks and drives and appurtenances shall be performed at all places indicated, to the lines, grades, and elevations shown, and shall be performed in such a manner that the requirements for formation of slopes, lines and grades can be followed. All material encountered, of whatever nature, within the limits indicated, shall be removed and disposed of as directed. During the process of grading, the subgrade shall be maintained in such condition that it will be well drained at all times. When directed, temporary drains and drainage ditches shall be installed to intercept or divert surface water which may affect the prosecution or condition of the work.

B. If at the time of grading it is not possible to place any material in its proper section of the permanent structure, it shall be stockpiled in approved areas for later use. No extra payment will be made for the stockpiling or double handling of excavated material.

C. The right is reserved to make minor adjustments or revisions in lines or grades if found necessary as the work progresses, due to discrepancies or in order to obtain satisfactory construction.

D. Stones or rock fragments larger than 4" in their greatest dimensions will not be permitted in the top 6" of the finished subgrade of all fills or embankments.

E. In cuts, all loose or protruding rocks on the backslopes shall be barred loose or otherwise removed to line or finished grade of slope. All cut and fill slopes shall be uniformly dressed to the slope, cross section and alignment shown.
3.10 DEFINITION OF ROCK

A. General Excavation - Any material which cannot be excavated with a single-tooth ripper drawn by a crawler tractor having a draw bar pull rated at not less than 56,000 pounds (Caterpillar D8K or equivalent) or excavated by a front-end loader with a minimum bucket breakout force of 25,600 pounds (Caterpillar 977 or equivalent).

B. Trench Excavation - Any material which cannot be excavated with a backhoe having a bucket curling force rated at not less than 33,000 pounds (Caterpillar 225B or equivalent).
SECTION 31 23 10
EXCAVATING, BACKFILLING, AND COMPACTING FOR STRUCTURES

PART 1 - GENERAL

1.01 SECTION INCLUDES
A. Section includes the excavation, backfilling and compacting required for the structures shown in the Contract Drawings.

1.02 RELATED SECTIONS
A. Section 01 33 00 - Submittals.
B. Section 01 45 24 - Structural Testing/Inspection Agency Services.

1.03 REFERENCES
B. ASTM D698 - Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³).
C. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
E. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.04 DEFINITIONS
A. Granular sub-base: Granular fill directly beneath slabs-on-grade.
B. Granular Backfill: Fill immediately behind foundation elements or retaining walls.
C. Structural fill: Fill under the structure other than the granular sub-base.

1.05 SUBMITTALS
A. Upon request, submit soil test reports performed by the Structural Testing/Inspection Agency.

1.06 QUALITY ASSURANCE
A. Structural Testing/Inspection Agency shall perform the following quality related items:
1. Verify structural fill complies with specifications.
2. Determine particle size, liquid limit, plastic limit, plasticity index and maximum density of each type of soil.
3. Observe proofrolling.
4. Perform a sufficient number of field density tests to verify compaction of structural fill. As a minimum, perform one test per lift for every 2500 square feet of fill placed.
5. Verify foundation bearing capacity.
6. Verify quantities of material removed and quantities of material placed where Unit Prices are involved.

1.07 SURVEY

A. Prior to construction, have structure location staked and certified by a licensed surveyor. If discrepancies between actual lines and elevations exist, notify Architect/Structural Engineer before proceeding with layout of structure.

1.08 SUBSURFACE CONDITIONS

A. Copies of a subsurface investigation of the site will be made available upon request. The data is not intended as a representation or warranty of the continuity of such conditions. Owner will not be responsible for interpretation or conclusions drawn therefrom by the Contractor. The data is made available for the convenience of the Contractor and is not guaranteed to represent all conditions that may be encountered.

B. Contractor may examine the site and make his own subsurface explorations at no additional cost to the Owner. Notify Owner prior to making any subsurface explorations.

1.09 EXISTING UTILITIES

A. Locate existing underground utilities by careful hand excavation. If utilities are to remain in place, provide protection from damage during construction operations.

B. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Do not interrupt existing utility service facilities occupied and used by Owner or others, unless written permission is given by the Architect and then only after temporary utility services have been provided.

C. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, consult the Architect immediately for directions.

D. Repair damaged utilities to satisfaction of utility owner.

1.10 NOTICE

A. Notify the Architect/Structural Engineer 48 hours prior to the beginning of any excavation work.
PART 2 - PRODUCTS

2.01 GRANULAR SUB-BASE
   A. Granular sub-base shall be sound and free-draining, such as sand, gravel or crushed stone with less than 10% passing the 200 sieve. Maximum diameter shall be 1-1/2 inches.

2.02 GRANULAR BACKFILL
   A. Backfill shall meet the requirements of the granular sub-base.

2.03 STRUCTURAL FILL
   A. Structural fill shall be low to moderate plasticity soil with Liquid Limit of less than 40 and a Plasticity Index of less than 20.
   B. Structural fill shall be free of organics, debris and deleterious materials.

PART 3 - EXECUTION

3.01 STRIPPING
   A. Strip vegetation, topsoil, roots, and other unsuitable material to a depth determined by the Structural Testing/Inspection Agency but not less than one foot, nor less than 10 feet outside the perimeter of the structure.
   B. Stockpile sufficient amounts of topsoil as required to cover areas to be landscaped with a minimum of six inches of material.

3.02 EXCAVATION
   A. Excavation shall be considered unclassified.
   B. Perform excavation to the depths and limits on the Drawings and as specified herein.
   C. Do not excavate to full depth when there is probability of frost forming or ground freezing in excavation before concrete is placed.
   D. Remove unsuitable soils located by proofrolling (see PROOFROLLING section below) and as noted in the geotechnical report.
   E. Ground water may be encountered during the foundation excavation. Provide a system for controlling the ground water to a level at least three feet below the lowest point of the excavation.
   F. Keep excavations dry by sloping ground away from holes and trenches.

3.03 PROOFROLLING
   A. After stripping or excavation and before any fill placement, fill areas shall be proofrolled with a minimum of two coverages of a loaded dump truck or scraper in each of two perpendicular directions.
B. Areas found to be soft or pumping shall have the soft soil removed and replaced with structural fill and compacted as outlined herein.

3.04 PLACEMENT OF STRUCTURAL FILL

A. Do not place structural fill on subgrade that contains frost, mud or is frozen.
B. Structural fill shall be placed and compacted in 8-inch thick loose layers.
C. Compact structural fill to 95 percent of the maximum dry density as measured by Standard Proctor, ASTM D698. For fill within the top 2 feet below the foundation and slab, compact structural fill to 98 percent of the maximum dry density as measured by Standard Proctor, ASTM D698. The water content during fill compaction should be kept within +3/-3 percent of the optimum moisture content.

3.05 PLACEMENT OF GRANULAR SUB-BASE

A. Do not place granular sub-base on subgrade that contains frost, mud or is frozen.
B. Compact granular sub-base to 98 percent of the maximum dry density as measured by Standard Proctor, ASTM D698. The water content during subbase compaction should be kept within +3/-3 percent of the optimum moisture content.

3.06 CLEAN UP

A. Remove excess excavated materials from job site and upon completion leave site in clean condition.

END OF SECTION
SECTION 31 23 10

EXCAVATION, BACKFILL, FILL AND GRADING FOR PIPE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section includes, except as elsewhere provided, all excavation for piping and associated appurtenances including; filling, backfilling, grading, disposal of surplus material and restoration of trench surfaces and easements.

B. Furnish and place all sheeting, bracing, and supports and remove from the excavation all materials which the Engineer may deem unsuitable for backfilling. The bottom of the excavation shall be firm, dry and in all respects acceptable. Deposit pipe bedding, or refill for excavation below grade, directly on the bottom of the trench immediately after excavation has reached the proper depth and before the bottom of the trench has become softened or disturbed by any cause whatever. The length of open trench shall be related closely to the rate of pipe laying. All excavation shall be made in open trenches.

1.02 RELATED WORK

A. Division 31: Site Preparation.

B. Division 31: Excavation, Filling, Backfilling, Grading for Structures

PART 2 - MATERIALS

2.01 MATERIALS

A. General:

1. Materials for use as fill shall be as described below. For each material, notify the Owner's representative of the source of the material and furnish, for approval, a representative sample weighing approximately 50 pounds, at least ten calendar days prior to the date of anticipated use of such material.

2. Materials shall be furnished as required from off site sources and hauled to the site.

3. Disposal of unsuitable materials is specified in this Section. See paragraph 3.01.

B. Common Fill:

1. Common Fill shall consist of mineral soil, free of organic material, loam, wood, trash, snow, ice, frozen soil and other objectionable material which may be compressible or which cannot be compacted properly. Common fill shall not contain stones larger than 10" in any dimension, broken concrete, masonry, rubble, or other similar materials. It shall have physical properties such that it can be readily spread and compacted during filling.

2. Material falling within the above specification, encountered during the excavation, may be stored in segregated stockpiles for reuse. All material which, in the opinion of the Owner's Representative, is not suitable for reuse shall be spoiled as specified herein for disposal of unsuitable materials.
C. Crushed Stone:

1. Crushed stone shall be used for pipe bedding, manhole bases, as a drainage layer below structures with underdrains and at other locations indicated on the drawings.

2. Crushed stone shall be size No. 57.

PART 3 - EXECUTION

3.01 DISPOSAL OF MATERIALS

A. Excavated material shall be stacked without excessive surcharge on the trench bank. Inconvenience to traffic and abutters shall be avoided as much as possible. Excavated material shall be segregated for use in backfilling as specified below.

B. Surplus excavated material which is suitable for use in backfilling or for replacing rock and boulders shall be stockpiled. Unsatisfactory surplus material including paving, rock or boulders and other material, shall be disposed of.

C. It is expressly understood that no excavated material shall be removed from the site of the work or disposed of by the Contractor except as directed by the Owner's representative.

D. Should conditions make it impracticable or unsafe to stack material adjacent to the trench, the material shall be hauled and stored. When required, it shall be re-handled and used in backfilling the trench. No extra compensation will be made for re-handling material.

3.02 SHEETING AND BRACING

A. Furnish, put in place, and maintain sheeting and bracing required to support the sides of the excavation and prevent loss of ground which could damage or delay the work or endanger adjacent structures. Care shall be taken to prevent voids outside of the sheeting, but if voids are formed, they shall be immediately filled and rammed.

3.03 TEST PITS

A. Contact and coordinate with local utilities before excavating test pits for the purpose of locating underground utilities of structures as an aid in establishing the precise location of new work. Test pits shall be backfilled as soon as the desired information has been obtained. The backfilled surface shall be maintained in a satisfactory condition for travel until resurfaced as hereinafter specified.

B. Excavation of test pits shall be considered work incidental to furnishing and laying sewer pipe.

C. If, for any reason, a test pit is left open for any period of time, it shall be barricaded and lighted.

3.04 DRAINAGE

A. Furnish all materials and equipment and perform all incidental work required to install and maintain the drainage system proposed for handling groundwater or surface water
encountered. Construction shall not begin until the Owner’s representative is assured that the proposed method will be satisfactory. The requirements for a stable subgrade are indicated above, and the Contractor must alter his drainage methods if the trench bottom is unsatisfactory.

B. Provide pumping equipment and devices to properly remove and dispose of all water entering trench and excavation for structures. The grade shall be maintained acceptably dry until structures to be built therein are completed. All drainage shall be performed without damage to the trench, pavements, pipes or other utilities.

C. Pipe and masonry shall not be laid in water or submerged within 24 hours after being placed. Water shall not flow over new masonry within four days after placement.

D. In no event shall water rise to cause unbalanced pressure on structures until the concrete or mortar has set at least 24 hours. Prevent flotation of the pipe by promptly placing backfill.

E. If underdrains are used for handling water, furnish and install pipe and crushed stone graded from coarse to fine, and furnish and install all pumps and equipment necessary to maintain the water level continuously at the required elevation. Pipe underdrains shall be laid with open joints and bedded in crushed stone for the full width of trench, to a depth of 6” below the invert of underdrain.

F. The invert of underdrain shall be 12” below the normal subgrade. Pipe underdrains shall have no permanent outlet and shall be sealed at the completion of the work. The length of continuous underdrain to be used shall be limited as conditions require. An impervious bulkhead of clay or concrete shall be constructed in the trench bottom between 100 ft. lengths of the underdrainage system to obstruct the free flow of groundwater after construction is completed. For all excavation below normal grade for the purpose of installing underdrains, the crushed stone and underdrain pipe shall be considered a part of the drainage work to be done under the pipe items. Continuously guard against the loss of earth through subbase or the underdrain. Should loss of either take place, alter the stone size to provide a satisfactory barrier or filter.

G. Where other methods of handling water prove inadequate, furnish, install, operate, and remove proper well point facilities.

3.05 TRENCH EXCAVATION (UNCLASSIFIED)

A. Excavation shall be made for all trenches which are required for the installation of pipes and manholes.

B. Make excavations to the depth indicated on the drawings and in such a manner and to such widths as will give suitable room for laying the pipe within the trenches, for bracing and supporting, and for pumping and drainage facilities. Render the bottom of the excavations firm and dry in all respects.

C. The trench may be excavated by machinery to, or just below the designated subgrade provided that the material remaining in the bottom of the trench is no more than slightly disturbed.

D. Rock shall be removed to a minimum of 8" clearance around the bottom and sides of the pipe being laid.

E. Where the pipes or ducts are to be laid directly on the trench bottom, the lower part of the trenches shall not be excavated to grade by machinery. The last of the material being
excavated manually shall be done in such a manner that it will give a flat bottom true to grade, so that pipe or duct can be evenly supported on undisturbed material. Bell holes shall be made to provide proper bedding.

3.06 PIPE BEDDING

A. The Contractor shall furnish and install pipe on the type of bedding shown on the drawings and as specified herein. Regardless of the type of bedding used, holes in the trench shall be provided to receive the pipe bell. The hole excavated shall be sufficient to relieve pipe bells of all loads and yet provide support over the total length of the pipe barrel.

B. Bedding classes are as defined below and shown on the drawings:

1. Two (2) types of bedding are specified:
   a. For Class D Bedding, the trench bottom shall be hand shaped to receive the portion of the circumference of the pipe barrel shown on the drawings. Class D bedding shall be used for all pipe bedding unless shown otherwise in the drawings.
   b. For Class C bedding, sand shall be compacted in the trench bottom, and compacted around the pipe to a depth shown on the drawings.
      (1) Where the trench bottom has been excavated below grade, C bedding shall be used.
      (2) Where consolidated rock has been moved from the trench bottom, Class C bedding shall be used.

3.07 BACKFILLING

A. As soon as practicable after the pipe has been laid and jointed, backfilling shall begin and thereafter be prosecuted expeditiously. Where indicated on the drawings, crushed stone shall be placed and compacted to a point indicated on the detailed drawing.

B. After the required crushed stone bedding has been placed, or after the pipe has been properly bedded on a shaped trench bottom, Common Fill material shall be placed to a depth of 1'-0" over the top of the pipe. Backfill shall be thoroughly compacted by hand-tamping as placed.

C. Any space remaining between the pipe and side of the trench shall be packed full by hand shovel with sand, free from stones having a diameter greater than 2", and thoroughly compacted with a tamper as fast as placed up to a level of one (1) foot above the top of the pipe.

D. The filling shall be carried up evenly on both sides with at least one person tamping for each person shoveling material into the trench.

E. The remainder of the trench above the compacted backfill, as just described shall be filled and thoroughly compacted by rolling, ramming, or puddling, to prevent subsequent settling.

F. Where the pipes are laid across country, the trench backfill material shall be mounded 6" above the existing grade or as directed. Wherever a loam or gravel surface exists prior to cross country excavations, it shall be removed, conserved, and replaced to the full original
depth as part of the work under the pipe items. In some areas it may be necessary to remove excess material during the cleanup process, so that the ground may be restored to its original level and condition. If loam or topsoil is not stored it may be replaced with loam or topsoil of equal quality and quantity.

G. Where the pipes are laid in streets, the last 1'-0" layer shall be of Aggregate Base material otherwise thoroughly compacted.

H. Backfill around manholes shall be selected material, compacted by puddling. All backfill shall be compacted, especially under and over pipes connected to the structures. Selected backfill shall be free from stones larger than 3".

I. Rock fragments shall not be placed until the pipe has at least 2'-0" of earth cover. Small stones and rocks shall be placed in thin layers alternating with earth to insure that all voids are completely filled. Filling shall not be dropped into the trench in a manner to endanger the pipe. Rock fragments used shall not exceed 10 pounds.

J. Bituminous paving adjacent to or effected by the excavation shall be broomed and hosed-clean immediately after backfilling. Dust control measures shall be employed at all times.

3.08 RESTORING TRENCH SURFACE

A. Where the trench occurs adjacent to paved street, in shoulders, sidewalks, or in cross-country areas, thoroughly consolidate the backfill and maintain the surface as the work progresses. If settlement takes place, immediately deposit additional fill to restore the level of the ground.

B. The surface of any driveway or any other area which is disturbed by the trench excavation and which is not a part of the paved highway shall be restored to a condition at least equal to that existing before work began.

C. In sections where the sewer passes through grassy areas, remove and replace the soil, or loam seed. The depth of loam replaced shall be at least equal to that removed during trenching operations, but in no event shall it be placed less then 4" in depth.

3.09 FILL PLACEMENT

A. General:

1. Material placed in fill areas under and around structures shall be deposited within the lines and to the grades shown on the drawings, making due allowance for settlement of the material. Fill shall be placed only on properly prepared surfaces which have been inspected and approved by the Owner's Representative. No fill shall be placed on a frozen surface, nor shall snow, ice, or frozen material of any sort be placed in fill. If sufficient common fill material is not available from excavation on site, provide borrow as may be required.

2. Gravel base course material and crushed stone shall be provided as borrow.

3. Fill shall be brought up to substantial level lifts throughout the site, starting in the deepest portion of the fill. The entire surface of the work shall be maintained free from ruts, and in such condition that construction equipment can readily travel over any section. Fill shall not be placed against concrete structures until they have attained sufficient strength.
4. Fill shall be dumped and spread in layers by a bulldozer or other approved method. During the process of dumping and spreading, all roots shall be removed from the fill areas.

5. If the compacted surface of any layer of material is determined to be too smooth to bond properly with the succeeding layer, it shall be loosened by harrowing or by another approved method before the succeeding layer is placed.

6. All fill materials shall be placed and compacted in a dry condition. Dewater excavated areas as required to perform the work and in such a manner as to preserve the undisturbed state of the natural inorganic soils.

3.10 COMPACtion

A. Common Fill backfill material in trenches shall be placed in layers not to exceed eight (8) inches in depth as measured before compaction. Each layer shall be compacted by a minimum of four (4) coverages with the equipment described below, to at least 98% of maximum dry density as determined by ASTM D698, unless under a structure in which case 100% compaction shall be obtained. Incidental compaction due to traffic by construction equipment will not be credited toward the required minimum four (4) coverages.

B. Common fill not within trenches shall be placed and compacted in a manner similar to that described above, with the following exceptions: layer thickness prior to compaction may be increased to 10" in open areas; and common fill except dike fill, required below water level in peat excavation areas may be placed as one lift, in-the-wet, to an elevation one (1) foot above the water level at the time of filling.

C. Compaction equipment in open areas shall consist of fully loaded ten-wheel dump trucks, tractor dozers weighing at least 30,000 pounds and operated at top speed, or by vibratory roller.

D. Areas adjacent to structures and other confined areas inaccessible to the roller or truck, the Common Fill shall be compacted with approved hand guided mechanical compaction equipment. Compaction of the Common Fill by such means shall be to the same degree of compaction as obtained by the rubber-tired equipment. Common Fill compacted by mechanical compactors shall be placed in loose lifts not to exceed 6" maximum thickness and to at least 98% of the standard Proctor maximum dry density.

E. It is the intention that the fill materials, with respect to moisture, be used in the condition they are excavated insofar as this is practicable. Material which is too wet shall be spread on the fill area and permitted to dry, assisted by harrowing if necessary, until the moisture content is reduced to allowable limits.

F. If the Owner's Representative shall determine that added moisture is required, water shall be applied by sprinkler tanks or other sprinkler systems, which will ensure uniform distribution of the water over the area to be treated, and give complete and accurate control of the amount of water to be used. If too much water is added, the area shall be permitted to dry before compaction is continued.

3.11 GRADING

A. Grading shall be performed at such places as are indicated on the drawings, to the lines, grades, and elevations shown and shall be made in such a manner that the requirements for formation of embankments can be followed. All unacceptable material encountered, of whatever nature within the limits indicated, shall be removed and disposed of as
directed. During the process of excavation, the grade shall be maintained in such condition that it will be well drained at all times. When directed, temporary drains and drainage ditches shall be installed to intercept or divert surface water which may affect the progress or condition of the work.

B. If at the time of excavation it is not possible to place any material in its proper section of the permanent structure, it shall be stockpiled in approved areas for later use.

C. The right is reserved to make minute adjustments or revisions in lines or grades if found necessary as the work progresses, due to discrepancies on the drawings or in order to obtain satisfactory construction.

D. Stones or rock fragments larger than 4" in their greatest dimensions will not be permitted in the top 6" of the subgrade line of all dikes, fills or embankments.

E. All fill slopes shall be uniformly dressed to the slope, cross-section and alignment on the drawings.

F. In cuts, all loose or protruding rocks on the back slopes shall be barred loose or otherwise removed to line or finished grade of slope. All cut and fill slopes shall be uniformly dressed to the slope, cross-section and alignment shown on the drawings.

G. No grading is to be done in areas where there are existing pipe lines that may be uncovered or damaged until such lines which must be maintained are relocated, or where lines are to be abandoned, all required valves are closed and drains are plugged at manholes.

3.12 DISPOSAL OF UNSUITABLE SURPLUS MATERIAL

A. Unsuitable and surplus activated materials and pavement shall become the property of the Contractor and removed and disposed of by him off the project site.

B. Suitable excavated materials may be used for fill or backfill if it meets the Specification for common fill. Excavated material so approved may be neatly stockpiled at the site. If space limitations do not permit stockpiling on the site, make arrangements for offsite stockpiling.

C. Surplus excavated materials may be used to fill depressions or other purposes as the Owner's Representative may direct.

3.13 DISPOSAL AND REPLACING OF ROCK

A. Remove and dispose of all pieces of rock which are not suitable for use in other parts of the work. Rock disposed of by hauling away to spoil area is to be replaced by approved surplus excavation obtained elsewhere on the site, insofar as it is available. Any deficiency in the backfill material shall be made up with acceptable material from outside sources as approved by the Owner's Representative.
SECTION 31 23 19
DEWATERING

PART 1 – GENERAL

1.01 RELATED DOCUMENTS
A. Drawings and general provisions of Contract, including General and Supplementary Conditions and General Requirements, apply to this Section.

1.02 SUMMARY
A. This Section includes provisions for site dewatering.
B. Dewatering consists of lowering and controlling groundwater levels and hydrostatic pressures to permit excavation and construction to be performed in near-dry conditions.
C. The Contractor shall determine the depth of soil below subgrade elevation that is to be dewatered.

1.03 SUBMITTALS
A. The Contractor shall submit the following in accordance with Conditions of Contract and General Requirements:
   1. A layout of the dewatering system to coordinate with other construction activities.
   2. Observation well reports recording elevation of groundwater and piezometric water levels.

1.04 QUALITY ASSURANCE
A. The Contractor shall perform dewatering operations with supervisory personnel having at least 5 years experience in field of dewatering.
B. The Contractor shall maintain adequate supervision and control to ensure that stability of excavated and constructed slopes are not adversely affected by water, that erosion is controlled and that flooding of excavation or damage to structures does not occur.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 DEWATERING
A. The Contractor shall provide an adequate system to lower and control groundwater in order to permit excavation, construction of structures and placement of fill materials under dry conditions. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of structure foundations, drains, sewers and other excavations.
B. The Contractor shall reduce hydrostatic head in water-bearing strata below structure foundations, drains, sewers and other excavations to extent that water level and piezometric water levels in construction areas are below prevailing excavation surface.

C. Prior to excavation below groundwater level, the Contractor shall place the system into operation to lower water levels as required and then operate it continuously 24 hours a day, 7 days a week until drains, sewers and structures have been constructed, including placement of fill materials and until dewatering is no longer required.

D. The Contractor shall dispose of water removed from excavations in a manner to avoid endangering public health, property and portions of work under construction or completed. The Contractor shall dispose of water in a manner to avoid inconvenience to others. The Contractor shall provide sumps, sedimentation tanks and other flow control devices as required by governing authorities.

E. The Contractor shall provide standby equipment on site, installed and available, for immediate operation if required to maintain dewatering on a continuous basis in event any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, the Contractor shall perform such work as may be required to restore damaged structures and foundation soils at no additional expense.

3.02 OBSERVATION WELLS

A. The Contractor shall provide, take measurements and maintain at least a minimum number of observation wells (piezometers) as indicated and additional observation wells as may be required by governing authorities.

B. The Contractor shall observe and record daily elevation of groundwater and piezometric water levels in observation wells.

C. The Contractor shall repair or replace within 24 hours, observation wells that become inactive, damaged, or destroyed. If required, suspend construction activities in areas where observation wells are not functioning properly until reliable observations can be made. The Contractor shall add or remove water from observation well risers to demonstrate that observation wells are functioning properly.

D. The Contractor shall remove observation wells when dewatering completed.
SECTION 31 25 00

TEMPORARY EROSION AND SEDIMENT CONTROL

PART 1 - GENERAL REQUIREMENTS

1.01 DESCRIPTION

A. The work specified in this Section consists of providing, maintaining and removing temporary erosion and sedimentation controls as necessary.

B. Temporary erosion controls include, but are not limited to, grassing, mulching, netting, and watering, and reseeding on-site surfaces and spoil and borrow area surfaces and providing interceptor ditches at ends of berms and at those locations which will ensure that erosion during construction will be either eliminated or maintained within acceptable limits as established by the Owner, City and State.

C. Temporary sedimentation controls include, but are not limited to, silt fencing, silt dams, traps, barriers, and appurtenances at the foot of sloped surfaces which will ensure that sedimentation pollution will be either eliminated or maintained.

D. Provide effective temporary erosion and sediment control measures during construction or until final controls become effective.

1.02 WORK SPECIFIED IN OTHER SECTIONS


B. Excavation, Backfill, Fill and Grading for Pipe: Division 31.

C. Seeding: Division 32.

1.03 REFERENCE DOCUMENTS

A. Georgia Building Code.

B. Any Soil Erosion and Sediment Control Ordinances in force by the local Government.

C. State of Georgia, Department of Transportation, Standard Specifications.

PART 2 - PRODUCTS

2.01 EROSION CONTROL

A. Seeding

B. Sodding

C. Netting - fabricated of material acceptable to the Owner.

2.02 SEDIMENTATION CONTROL

A. Bales - clean, seedfree cereal hay type.
B. Netting - fabricated of material acceptable to the Owner.

C. Filter stone - No. 57 - crushed stone.

PART 3 - EXECUTION

3.01 EROSION CONTROL

A. Minimum procedures for grassing are:

1. Scarify slopes to a depth of not less than 6" and remove large clods, rock, stumps, roots larger than 1/2" in diameter and debris.

2. Sow seed within 24 hours after the ground is scarified with either mechanical seed drills or rotary hand seeders.

3. Apply mulch loosely and to a thickness of between 3/4" and 1-1/2".

4. Apply netting over mulched areas of sloped surfaces.

5. Roll and water seeded areas in a manner which will encourage sprouting of seeds and growing of grass. Reseed areas which exhibit un-satisfactory growth. Backfill and seed eroded areas.

3.02 SEDIMENTATION CONTROL

A. Install and maintain silt fencing, silt dams, traps, barriers and appurtenances as shown on the approved descriptions and working drawings. Hay bales which deteriorate and filter stone which is dislodged shall be replaced.

3.03 PERFORMANCE

A. Should any of the temporary erosion and sediment control measures employed fail to produce results which comply with the requirements of the State, immediately take whatever steps are necessary to correct the deficiency.
SECTION 31 25 53
SILT FENCING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The work covered by this Section consists of furnishing all materials, equipment, and labor and performing all operations in connection with the construction of the Silt Fence System in accordance with the Contract Documents.

B. The surfaces to be protected shall be prepared and graded to the extent that they are normally stable in the absence of erosion forces. All stones, roots, and other waste material exposed on the slopes which could disturb the finished mat profile shall be removed. The fabric shall be positioned over these surfaces.

1.02 RELATED WORK

A. Site Work; Division 31.

B. Shop Drawings, Product Data and Samples; Division 1.

1.03 QUALIFICATIONS

A. Installation shall be by an experienced applicator approved by the manufacturer of the material supplied.

B. Applicator shall have a minimum of one year experience.

C. Submit written proof of qualifications to the Engineer.

D. The woven fiber filter and appurtenances specified under this Section shall be furnished by a manufacturer who is fully experienced, reputable, and qualified in the manufacture of the fabric furnished. The woven fiber filter and all related appurtenances shall be designed, constructed and installed with the best practices and methods.

E. The woven fiber filter and appurtenances shall be as manufactured by Carthage Mills, Cincinnati, Ohio, Staff Industries, Inc., Upper Montclair, or approved equal.

1.04 SUBMITTALS

A. Furnish sample 36 by 36 inches for each fabric, as specified in Division 1.

B. Final acceptance of fabric shall be contingent upon approval of samples.

C. Furnish an affidavit that all materials comply with these Specification requirements.

1.05 DELIVERY AND STORAGE

A. Prevent damage during delivery and handling.

B. Store all fabric in undamaged condition as packaged by the manufacturer, with manufacturer's seals and labels intact.
C. Store all materials in a clean, dry storage area.

D. Do not store fabric in an upright position.

E. Storage area temperature shall be maintained above 40 degrees F. with normal humidity.

PART 2 - PRODUCTS

2.01 FABRIC

A. The filter fabric shall be designed to control water seepage of the fine particle and or soil without clogging under varying water flow conditions, thereby serving as a soil stabilizer.

B. The filter fabric shall be chemically resistant to prolonged exposure to fresh water, and either alkaline or acidic soil conditions.

C. Physical Properties:

<table>
<thead>
<tr>
<th>Test Method</th>
<th>Description</th>
<th>Value</th>
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<tr>
<td>ASTM D-1682</td>
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<tr>
<td>ASTM D-1682</td>
<td>Elongation, %</td>
<td>34 x 32</td>
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<td>Trapezoidal tear strength, #</td>
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<td>ASTM D-751</td>
<td>Mullen burst, psi</td>
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<td>ASTM D-751-M</td>
<td>Puncture Strength, #</td>
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<td>Abrasion resistance</td>
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<td>Abraded strength, #</td>
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<td>Weather-Ometer strength retention, %</td>
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<td>Water permeability, water flow rates*, milliliters/min.</td>
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<td>36&quot; head</td>
<td>2510-2790</td>
<td></td>
</tr>
</tbody>
</table>

*Water flow perpendicular to fabric

D. The upper level of the fabric form work edges shall be structured so as to accommodate the type of anchorage to be utilized at that point.

E. Individual mill-width panels shall be cut to suitable lengths, and the two layers of fabric separately jointed, edge-to-edge, by means of heavy, double-stitched nylon thread. The tensile strength of stitched joints shall not be less than 100 lbs/inch.

PART 3 - EXECUTION

3.01 INSTALLATION
A. Installation instructions shall be supplied by the manufacturer. The fabric shall be applied in accordance with the manufacturer’s recommendations.
PART 1 - GENERAL

1.01 SUBMITTALS
   A. General: In compliance with Section 01 33 00 and as specified herein.
   B. Product Certificates; (FIO): Signed by manufacturer of termite control products certifying that treatments furnished and installed comply with requirements.

1.02 QUALITY ASSURANCE
   A. Applicator Qualifications: State licensed pest control operator.
   B. Regulatory Requirements: Formulate and apply termiticides, and label with a Federal registration number, to comply with EPA regulations and authorities having jurisdiction.

1.03 PROJECT CONDITIONS
   A. Owner's Representative shall be present at time of treatment and, upon request, shall be provided with samples of chemicals during application for independent testing for verification of content.
   B. Do not apply soil treatment solution until excavating, filling, and grading operations are completed, except as otherwise required in construction operations.
   C. Do not apply soil treatment to frozen or excessively wet soils or during inclement weather. Comply with handling and application instructions of soil treatment manufacturer.

1.04 SCHEDULING
   A. Give Architect and Owner 48 hours notice prior to time application of soil treatment is to commence.
   B. Make application during normal working hours.
   C. Allow minimum 12 hours for drying after application, before covering treated area.

1.05 WARRANTY
   A. Warranty: Furnish written Warranty, signed by Applicator and Contractor, certifying that applied soil termiticide treatment will prevent infestation of subterranean termites for period of five years from Date of Substantial Completion. Warranty shall be written in amount of Fifty Thousand Dollars ($50,000.00) for damages.
      1. If subterranean termite activity is discovered during warranty period, Contractor will retreat soil and repair or replace damage caused by termite infestation.
   B. Warranty shall state dates of application and chemicals used, including quantities and concentrations.
   C. Warranty shall be renewable on year-to-year basis at end of five year period, at Owner's option, for fee to be agreed upon at time of renewal.
   D. Retreatment, upon evidence of subterranean termite activity, shall be made at no charge to Owner.
PART 2 - PRODUCTS

2.01 MATERIALS

A. Acceptable Products: Toxicants shall be registered by the Environmental Protection Agency for their intended use and shall be accepted by the U.S. Department of Agriculture for use in controlling termite infestation of buildings, without being injurious to plant life.

B. Use an emulsible, concentrated termiticide that dilutes with water. Fuel oil will not be permitted as a diluent.

C. Mixtures of chemicals are prohibited, except as premixed from manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of the soil, interfaces with earthwork, slab and foundation work, landscaping, and other conditions affecting performance of termite control. Proceed with application only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's written instructions for preparing substrate. Remove all extraneous sources of wood cellulose and other edible materials such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil and around foundations.

B. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated, except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended by termiticide manufacturer.

C. Fit filling hose connected to water source at the site with a backflow preventer, complying with requirements of authorities having jurisdiction.

3.03 APPLICATION

A. Apply toxicant in compliance with label instructions and EPA requirements for subterranean or surface treatment.

B. Apply subterranean treatments by means of injection or trenching.

C. Perform no treatment when soil is wet or after rains. Avoid flow of toxicant from treated surfaces.

D. Treat soil before concrete slabs are placed, using following application rates:
   1. Slabs On-Grade and Basement Slabs; Horizontal Barriers: Apply one gallon of chemical solution per 10 square feet as an overall treatment under slab and attached slab areas where fill is soil or unwashed gravel. Apply 1-1/2 gallons of chemical solution per 10 square feet to areas where fill is washed gravel or other coarse absorbent material.
   2. Foundations; Vertical Barriers: Apply 4 gallons of chemical solution per 10 linear feet of trench for each foot of depth from grade to footing, along outside edge of building. Dig a trench 6-inches to 8-inches wide along outside of foundation to minimum depth of 12-inches. Punch holes to top of footing at maximum 12-inches o.c. and apply chemical solution. Mix chemical solution with soil as it is being replaced in the trench.
   3. Slab Penetrations: Apply 4 gallons of chemical solution per 10 linear feet.
E. At grade beams, treat voids at rate of 2 gallons per 10 linear feet poured directly into the hollow spaces.

F. At expansion joints, control joints, and areas where slabs will be penetrated, apply at rate of 4 gallons per 10 linear feet of penetration.

G. Post signs in areas of application to warn workers that soil termiticide treatment has been applied. Remove signs after areas are covered by other construction.

H. Reapply soil treatment solution to areas disturbed by subsequent excavation, landscape grading, or other construction activities following application.

I. Protect termiticide solution, dispersed in treated soils and fills, from being diluted until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.

END OF SECTION
SECTION 31 63 16
AUGERED CAST-IN-PLACE PILES

PART 1 - GENERAL

1.01 SECTION INCLUDES
A. Section includes the installation and testing of Augered Cast-In-Place (ACIP) Piles.

1.02 RELATED SECTIONS
A. Section 01 33 00 - Submittals.
B. Section 01 45 24 - Structural Testing/Inspection Agency Services.
C. Section 03 20 00 - Concrete Reinforcement.
D. Section 03 30 00 - Cast-in-Place Concrete.

1.03 BASIS OF PAYMENT
A. Bid price shall include furnishing the necessary tools, equipment, material, labor and supervision to perform the following in accordance with the Contract Documents.
   1. Mobilize and Demobilize.
   2. Install four to five probe piles near boring locations to verify installation criteria per the Geotechnical Report.
   3. Conduct one pile load test consisting of one compression test.
   4. Install a total bid length of ACIP piles, including reinforcement, as recommended by the soils report.
B. Pay length of ACIP piles shall be the total length (to the nearest foot) of all piles installed measured from the required bottom of the pile to the required top of pile, except:
   1. No payment will be made for rejected piles, and
   2. No payment will be made for any portion of the pile extending below the required bottom elevation of pile or continuing above the required top of pile elevation.
C. Bid price will be adjusted based on the actual number of load tests performed and the difference in linear footage between the total bid length and total pay length of all ACIP piles in accordance with the unit price stated in the bid form for the following:
   1. ACIP pile load test.
   2. ACIP pile installed, including reinforcement, per linear foot.

1.04 REFERENCES


1.05 SUBMITTALS

A. Submit Contractor qualifications demonstrating compliance with this specification with the bid.

B. Submit reinforcing steel in accordance with Section 03 20 00.

C. Submit grout mix design.

D. Submit ACIP pile layout plan referenced to the drawings with a pile numbering system that identifies each pile.

E. Submit drilling records not later than forty-eight (48) hours after drilling for each pile.

F. Submit an as-built of all piles in a given pile cap when any of the piles do not meet specified tolerances. The as-built shall clearly show the deviation of each pile with respect to the local centerline and orientation of the pile cap. The as-built slope of piles should be submitted for piles not meeting plumbness requirements. Pile numbers corresponding to the pile numbering system noted in D above shall be included in this as-built. A column grid location for the pile cap must be given with the submitted as-built.

G. Submit copies of each load test report.

1.06 QUALITY ASSURANCE

A. Structural Testing/Inspection Agency shall perform the following quality related items:
   1. Approve equipment to be used in installing the ACIP piles.
   2. Monitor the load tests.
   3. Observe the installation of all ACIP piles for compliance with the Contract Documents.
   4. Record unusual conditions encountered during pile installation.
   5. Prepare, store, and test specimens of pile grout for each eight-hour shift and for every 50 yd³ of grout placed whichever is more frequent, using either of the two compressive test methods specified below:
Form one set of six 2-inch cube specimens in accordance with ASTM C109.

Mold four 3-inch diameter cylinder specimens in accordance with ASTM C39. Perform one 7-day and two 28-day compressive strength tests.

For either method listed above, record:
   i. Flow cone
   ii. Temperature, ambient and grout
   iii. Location of placement
   iv. Any pertinent information, such as addition of water, addition of admixtures, etc.

6. Record the depth to which each ACIP pile is placed and the amount of material used in each pile.

B. Execute work in accordance with local and state regulations and codes and in accordance with the regulations of regulatory agencies having jurisdiction over the work.

C. Engage a registered surveyor to perform surveys, layouts, and measurements for ACIP piles.

1.07 QUALIFICATIONS

A. Contractor shall be qualified to install the ACIP piles specified in accordance with Drawings, Specifications, local codes and regulations, and subsurface conditions existing at the site.

B. Minimum qualifications are five years of ACIP pile experience and evidence of satisfactory completion of ten installations comparable in scope to that of this project.

1.08 SUBSURFACE CONDITIONS

A. Copies of subsurface investigation of the site will be made available upon request. The data is not intended as a representation of warranty of the continuity of such conditions. Owner will not be responsible for interpretation of conclusions drawn therefrom by the Contractor. The data is made available for the convenience of the Contractor and is not guaranteed to represent all conditions that may be encountered.

B. Contractor may examine the site and make his own subsurface explorations at no additional cost to the Owner. Notify Owner prior to making subsurface exploration.

1.09 EXISTING UTILITIES

A. Locate existing underground utilities by careful hand excavation. If utilities are to remain in place, provide protection from damage during construction operations.

B. Cooperate with Owner and utility companies in keeping their respective services and facilities in operation. Do not interrupt existing utility service facilities occupied and used by Owner or others, unless written permission is given by the Architect and then only after temporary utility services have been provided.

C. Should uncharted or incorrectly charted piping or other utilities be encountered, consult Architect immediately for directions.

D. Repair damaged utilities to satisfaction of utility owner.
PART 2 - PRODUCTS

2.01 ACIP PILES

A. The minimum diameter of ACIP piles shall be per the contract drawings.

B. A continuous flight hollow shaft auger shall be rotated into the ground to the required pile depth. Pile grout shall then be injected through the auger shaft as the auger is being withdrawn in such a way as to exert removing pressure on the withdrawing earth-filled auger as well as lateral pressure on the soil surrounding the grout filled pile hole.

C. Proposals of alternate methods will be considered, however, they shall be such that a full pile occurs, and that the design working loads are obtained. Alternate proposals shall be complete and in sufficient detail to be readily evaluated by the Structural Engineer. Load Tests, in addition to that set forth in the bid schedule, required to verify alternate methods, shall be conducted at the expense of the Contractor.

2.02 MATERIALS

A. Grout
   1. Pile grout shall consist of a mixture of Portland cement, fine aggregate, water, and other approved additives so proportioned and mixed as to produce a grout capable of maintaining the solids in suspension without appreciable water gain and which may be pumped without difficulty. Pozzolan conforming to these Specifications may be used at the option of the Contractor.
   2. Minimum compressive strength shall be 4,500 psi at 28 days.

B. Reinforcement
   1. ACIP piles shall be reinforced as indicated on the Drawings.

C. Portland Cement
   1. Portland cement shall conform ASTM C150.

D. Fine Aggregate
   1. Fine aggregate (sand) shall meet the requirements of ASTM C33. Sand shall have a fineness modulus between 1.40 and 3.40. The fineness modulus is defined as the total of the cumulative percentages retained on U.S. Standard Sieve No. 15, 30, 50, and 100 divided by 100.

E. Pozzolan
   1. Pozzolan shall be, if used, a finely divided material composed essentially of compounds of amorphous silica, alumina, and iron, which possesses the property of combining lime liberated during the process of hydration of Portland cement, and shall conform to ASTM C595.

F. Fluidifier
   1. Fluidifier or other placement aids that inhibit early stiffening, decrease bleeding, eliminate setting shrinkage, increase fluidity, produce the effect of an air entraining agent with respect to freezing and thawing, shall conform to requirements of ASTM C937.

G. Water
   1. Water shall be fresh, clean, and free from injurious amount of sewage, oil, acid, alkali, salts, or organic matter.
PART 3 - EXECUTION

3.01 ACIP PILES

A. ACIP Piles shall be located as indicated on the Drawings or as otherwise directed by the Structural Engineer.

B. Piles shall not be installed within six pile diameters center to center of a pile filled with grout less than 24 hours old.

C. In the event that non-augerable material is encountered which prevents placing of a pile to the depth required, the short pile shall be completed as described in this Specification, and if necessary, an additional adjacent pile shall be placed as directed by the Structural Testing/Inspection Agency.

D. Pile diameter or bottom of pile elevation may be revised by the Structural Engineer as a result of soil information obtained during pile installation or as a result of pile load tests.

E. Pile cut-off may be accomplished by removing fresh grout from the top of the pile or by cutting off grout down to final cut-off point after initial set has occurred.

3.02 MATERIALS

A. Materials shall be accurately measured by volume or weight as they are fed into the mixer.

B. The quantity of water used shall be such as to produce a grout having a consistency of not less than 15 seconds but not more than 30 seconds when tested with a flow cone in accordance with ASTM C939 with the exception that the orifice diameter limit shall be revised from ½” to ¾”. Time of mixing shall be not less than one minute. If agitated continuously, the grout may be held in the mixer or agitator for a period not exceeding two hours at temperatures below 70°F and for a period not exceeding one and one-half hours at higher temperatures. If there is a lapse in the operation of grout injection, the grout shall be recirculated through the pump, or through the mixer drum (or agitator), and pump.

3.03 INSTALLATION

A. Only approved mixing and pumping equipment shall be used in the preparation and handling of pile grout. A screen to remove oversize particles shall be used between the mixer and pump, or between the mixer and agitator.

B. Oil or other rust inhibitors shall be removed from the mixing drums, stirring mechanisms, and other portions of the equipment in contact with the grout before the mixers are used.

C. Augering or grout injection equipment shall be provided with a grout pressure gage in clear view or the equipment operator. Rate of grout injection and rate of auger withdrawal from the soil shall be so coordinated as to maintain at all times a positive pressure on this gage, which will, in turn, indicate the existence of a "removing pressure" on the bottom of the auger flight in conformance with these specifications.

D. The hole in the bottom of the auger shall be plugged while the auger is advanced into the ground. Prior to grouting, the auger may be raised a reasonable distance (approximately 1 foot), and the plug shall be removed by grout pressure. Following this procedure, the auger shall be rotated to its original depth to ensure that the grout is being placed at the bottom of the augered hole. The auger shall remain rotating when the grout is being pumped and shall have a positive rotation throughout the pumping process. If there is a lapse in the operation
of pumping, the grout shall be recirculated through the pump, or through the mixer drum and agitator and pump.

E. The rate of auger withdrawal shall be slower than the rate of grout filling so that the grout will tend to consolidate soft or weak soil zones and to extend into and fill fissures or crevices encountered. The volume of grout material shall be at least 30% greater than the net volume of the pile specified. Contractor shall provide a positive method, satisfactory to the Structural Testing/Inspection Agency for determining the volume of grout placed to the nearest two cubic feet. Auger hoisting equipment shall be so designed as to enable the auger to be withdrawn smoothly and steadily at a constant rate. If the auger jumps upwardly during removal, the auger shall be reinserted into the grout.

F. Magnitude of "removing pressure" and performance of other augering and grouting operations such as the rate of augering, rate of grout injection, control of grout return, and equipment capability shall be entirely at the direction and under the responsibility of the Contractor, except that pressures that would cause heaving of the ground or otherwise damage the foundation soil or completed adjacent piles shall not be allowed.

3.04 TOLERANCES

A. Pile centers shall be located to an accuracy of plus or minus two inches in plan.

B. Pile centers shall be plumb within 2 percent of vertical.

C. Top of pile elevation shall be within plus or minus 2 inches of the elevation indicated on Contract Documents.

3.05 LOAD TEST

A. Pile axial compressive, tension, and lateral load tests shall be performed in accordance with ASTM D1143, ASTM D3689, ASTM D3966 and these specifications. The compressive load test can be performed in accordance with the Quick Test method of ASTM D1143.

B. Pile load tests shall be conducted by the Contractor and approved by the Structural Testing/Inspection Agency prior to the installation of production piles.

C. Test pile locations shall be located and approved by the Geotechnical Engineer of Record prior to the installation the test piles. The test locations will be selected based on the results of 4 to 5 probe piles at various locations around the site.

D. The test piles shall be installed with the same equipment and under the same placement conditions as will be used for the production piles.

E. Contractor shall provide a registered professional engineer experienced in pile load testing to design and conduct the testing program.

F. The pile load test shall include accurate deflection measurements from two independent systems.

G. Test piles will be considered as having passed the axial compressive load test if, when subject to a load of twice the design load, the permanent net settlement is not more than 3/4 inches. The pile also must support twice the design load without exhibiting a plunging type failure. It is recommended that the test pile be loaded to failure in order to more accurately determine ultimate capacities and recommended working loads for production foundations.
H. Contractor shall submit to the Structural Testing/Inspection Agency a complete report of the load test in accordance with ASTM D1143, ASTM D3689, and ASTM D3966 for each load test.

END OF SECTION
SECTION 32 01 17
PAVEMENT REPAIR AND RESTORATION

PART 1 - GENERAL

1.01 SCOPE OF WORK
A. Furnish all labor, materials equipment and incidentals required and remove and replace pavements over trenches excavated for installation of water lines as shown on the Drawings and/or specified herein.

1.02 RELATED WORK
A. Earth excavation and backfill, Division 31.
B. Crushed stone is included under Division 31.

1.03 GENERAL
A. All damage, as a result of work under this project, done to existing structures, pavement, driveways, paved areas, curbs and gutters, sidewalks, shrubbery, grass, trees, utility poles, utility pipe lines, conduits, drains, catch basins, flagstones, rocked, graveled or stabilized areas or driveways and including all obstructions not specifically named herein, shall be repaired in a manner to restore the surface to its original condition. The scope of work shall include the furnishing of all labor, materials, equipment and incidentals necessary for the cutting, repair and restoration of the damaged areas.
B. The Contractor shall keep the surface of the backfilled area of excavation in a safe condition and level with the pavement restored in the manner specified herein. The last 10 inches of the backfill shall be compacted crusher-run gravel to provide a temporary finished surface until the pavement is replaced. All surface irregularities that are dangerous or obstructive to traffic are to be removed.
C. All materials and workmanship shall be first class and nothing herein shall be construed as to relieve the Contractor from this responsibility. The Owner reserves the right to require soil bearing or loading tests or materials tests, should the adequacy of the foundation or the quality of materials used be questionable. Costs of these tests shall be borne by the Owner.
D. All street, road, driveway and highway repair shall be made in accordance with the details indicated on the Drawings.
E. No permanent pavement shall be placed over a backfilled trench within 90 days after completion of the backfilling, unless permitted to do so in writing by the Owner's Representative.

PART 2 - PRODUCTS

2.01 ASPHALT PAVEMENT SURFACE
A. The material shall be Type E, Bituminous Concrete
2.02 CONCRETE PAVEMENT SURFACE
   A. The material shall be a 4,000 psi strength mix design.

2.03 TEMPORARY PAVEMENT
   A. The material shall be Type B, Bituminous Concrete. Temporary pavement shall be maintained until replaced by permanent pavement.

   B. If points of settlement or holes appear in the temporary pavement, the Contractor shall repair the same within three days of notification by the Owner. Where permanent pavement is to be installed, the Contractor shall remove the temporary pavement and regrade the subbase for installation of permanent pavement.

PART 3 - EXECUTION

3.01 CUTTING PAVEMENT
   A. The Contractor shall cut and remove pavement as necessary for installing the new pipe lines and appurtenances and for making connections to existing pipe lines.

   B. Before removing pavement, the pavement shall be marked for cuts nearly paralleling pipe lines and existing street lines. Asphalt pavements shall be cut 4 inches deep, along the markings with a jackhammer, rotary saw. Concrete pavement and asphalt pavement on concrete base, shall be scored to a depth of approximately two (2) inches below the surface of the concrete along the marked cuts. Scoring shall be done by use of a rotary saw, after which the pavement may be broken below the scoring with a jackhammer or other suitable equipment.

   C. No pavement shall be machine pulled until completely broken and separated along the marked cuts.

   D. The pavement adjacent to pipe line trenches shall neither be disturbed nor damaged. If the adjacent pavement is disturbed or damaged, irrespective of cause, the Contractor shall remove the damaged pavement and shall replace it at his own expense.

3.02 PAVEMENT REPAIR AND REPLACEMENT
   A. All existing pavement cut or damaged by construction under this contract shall be repaired to match the original surface material and original grade unless otherwise specified or shown on the Drawings.

   B. The repair shall include the preparation of the subgrade, the placing and compacting of the base course, the priming of the base, the placing and maintaining of the surface treatment and any special requirements, all as specified herein. All base course to receive an asphaltic concrete surface shall be finished 2 inches compacted thickness of asphaltic concrete. Stabilized roads and drives shall be finished to match the grade of the existing pavement. Dirt roads and drives shall have the final two inches of the backfill material up to the finished surface as crushed stone.

   C. Wherever the water line is run parallel to and within the limits of a paved street under this Contract, the entire width of such street shall be reconstructed and surfaced in accordance with these Specifications. The base shall be 2 feet wider than the street surface, one foot on each side of the surface edge.
D. The width of all repairs shall extend at least 12 inches beyond the excavation or limits of any damaged section. The edge of the pavement to be left in place shall be cut to a true edge with a saw or other approved method so as to provide a clean edge to abut the repair. The line of the repair shall be reasonably uniform with no unnecessary irregularities.

3.03 MISCELLANEOUS RESTORATION

A. Trenches cut across sidewalls shall be restored in full sections or blocks to a minimum thickness of four inches. Concrete curb or curb gutter shall be restored to the existing height and cross section in full sections or lengths between joints. Concrete shall be as specified in Division 3. Grassed yards, shoulders and parkways shall be restored to match the existing sections with grass of a type matching the existing grass.

3.04 SPECIAL REQUIREMENTS

A. The restoration of all surfaces, as described herein, disturbed by the installation or repair to underground facilities shall be completed as soon as is reasonable and practical. In no case shall the surface go unfinished for more than five (5) calendar days after backfilling.

3.05 CLEAN-UP

A. After all repair and restoration or paving has been completed, all excess asphalt, dirt, rock and other debris shall be removed from the roadways. All existing storm sewers and inlets shall be checked and cleaned of any construction debris.

3.06 MAINTENANCE

A. All wearing surfaces shall be maintained by the Contractor in good order and be suitable for traffic at all times for a period of one year after completion and acceptance of the work. Approximately at the end of the maintenance period a final inspection will be made of the repaired surface and any settlement or depression shall be adjusted as previously noted herein.

END OF SECTION
SECTION 32 13 13
PORTLAND CEMENT CONCRETE PAVING

PART 1 - GENERAL

1.01 APPLICABLE PUBLICATIONS:

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

A. American Concrete Institute (ACI) Publications:

211.1-81 (R1985) Selecting Proportions for Normal, Heavyweight, and Mass Concrete
301-84 Structural Concrete for Buildings
305R-77 (R1982) Hot Weather Concreting

B. American Society for Testing and Materials (ASTM) Publications:

C 31-85 Making and Curing Concrete Test Specimens in the Field
C 33-86 Concrete Aggregate
C 78-84 Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
C 94-86 (REV. B) Ready-Mixed Concrete
C 143-78 Slump of Portland Cement Concrete
C 150-85 (REV. A) Portland Cement
C 171-69 (R1986) Sheet Materials for Curing Concrete
C 172-82 Sampling Freshly Mixed Concrete
C 231-82 Air Content of Freshly Mixed Concrete by the Pressure Method
C 260-86 Air-Entraining Admixtures for Concrete
C 309-81 Liquid Membrane-Forming Compounds for Curing Concrete
C 494-86 Chemical Admixtures for Concrete
C 595-86 Blended Hydraulic Cements
C 618-85 Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
D 41-85  Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
D 98-87  Calcium Chloride

1.2  SUBMITTALS:

A. Contractor Furnished Mix Design: Thirty days minimum prior to concrete placement, submit a mix design for each strength and type of concrete. Furnish a complete list of materials including type, brand, source and amount of cement, fly ash, pozzolan, admixtures, and applicable reference specifications.

B. Laboratory Test Reports: Submit results of fly ash and pozzolan testing and shown that the mix has been successfully tested to produce concrete with the properties specified and will be suitable for the job conditions. Obtain approval before concrete placement.

C. Field Test Reports: Submit testing results in accordance with ASTM C 31 and as required in paragraph entitled "SAMPLING AND TESTING."

D. Certificates of Conformance:
   1. Aggregates
   2. Admixtures
   3. Cement
   4. Fly ash
   5. Pozzolan
   6. Reinforcing

E. Manufacturer's Data
   1. Materials for curing concrete
   2. Admixtures
   3. Bondbreaker
   4. Superplasticizer
   5. Mooring eyes

1.03  DELIVERY AND STORAGE: ACI 301

PART 2 - PRODUCTS

2.01  MATERIALS

A. Cement: ASTM C 150, Type I.

B. Water: Fresh, clean, and potable

C. Aggregates: Free from any substance which may be deleteriously reactive with the alkalies in the cement.

2. Coarse Aggregates: ASTM C 33, Size No. 57.

D. Admixtures. Where not shown or specified, the use of admixtures is subject to written approval of the Contracting Office.


2. Retarding: ASTM C 494, Type B or D.


4. Water Reducing: ASTM C 494, Type A, D, E, F, or G.

5. Fly Ash and Pozzolan: ASTM C 618, type N, F, or C, except that the maximum allowable loss on ignition shall be 6 percent for Type N and F.

E. Forms: Wood, plywood, steel, or other suitable material.

F. Reinforcement:

1. Dowels steel shall be intermediate grade, steel bars conforming to ASTM Designation A625, Grade 60. Rail-steel bars will not be permitted in the work.

2. Reinforcing steel shall be deformed, intermediate grade, steel bars conforming to ASTM Designation A615, Grade 60. Rail-steel bars will not be permitted in the work.

G. Curing Materials

1. Impervious Sheeting: ASTM C 171 with a minimum sheet thickness of 10 mils.

2. Liquid Membrane-forming Compound: STM C 309, white pigmented, Type 2, Class B, free of paraffin or petroleum.


J. Bondbreaker: ASTM D 41.

K. Mooring Eyes: Ductile iron, for rop clip and hook type anchors, 9,000 lb. bending load capacity.

2.02 CONTRACTOR-FURNISHED MIX DESIGN:

Design mix in accordance with ACI 211.1. The concrete shall conform to the following

<table>
<thead>
<tr>
<th>Minimum Flexural Strength 28 Days (psi)</th>
<th>Maximum Aggregate Size (inches)</th>
<th>Min. Cement Content lbs./yd³</th>
<th>Maximum Water-Cement Ratio (by weight)</th>
<th>Range in Slump (In.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlanta Airport AC Hotel</td>
<td>Portland Cement Concrete Paving</td>
<td>216014.00</td>
<td>32 13 13</td>
<td></td>
</tr>
</tbody>
</table>
A. Allowable air content: 5 percent plus or minus 1.5 percent by volume.

B. The minimum cement content is required for durable concrete with local aggregates by may be insufficient to obtain the specified strength, in which case, increase the cement content as necessary, with out additional compensation under the contract.

C. Do not include fly ash content when calculating the cement content.

PART 3 - EXECUTION

3.01 FORMS:

A. General: Construct forms to be removable without damaging the concrete. In lieu of setting forms, the edge of an existing pavement section may be used as a form.

B. Coating: Before placing the concrete, coat the contact surfaces of forms with a non-staining mineral oil, non-staining form coating compound, or two coats of nitro-cellulose lacquer. When using existing pavement as a form, clean existing concrete and then coat with a bondbreaker before concrete is placed.

C. Grade and Alignment: Check and correct grade elevations and alignment of the forms immediately before placing the concrete.

3.02 REINFORCEMENT:

A. Reinforcement shall be newly rolled, of domestic manufacture, free from rust, scale, dirt, grease, and injurious contaminants and shall be of intermediate grade billet steel conforming to ASTM Specification A615, Grade 60.

B. Reinforcement, where required, shall be accurately placed in exact positions shown, shall be secured against displacement with annealed iron wire tires or suitable clips at intersections, and shall have a clear space of 2 inches between the steel and face of forms for the purpose of holding the steel in proper position. Concrete blocks with wire ties cast therein may be used whereas approved by the Engineer for the purpose of maintaining and clearance between reinforcement and forms.

C. Reinforcement shall be accurately fabricated to the dimensions indicated on the Drawings. Stirrups and tie bars shall be bent around a pin having a diameter not less than two times the minimum thickness of the bar. Bends for other bars shall be made around a pin having a diameter not less than six times the minimum thickness except for bars larger than 1 inch, in which case the bends shall be made around a pin of 8-bar diameters. All bars shall be bent cold.

D. Rail-steel will not be allowed in the work.

E. Metal chairs shall not be used for support unit reinforcing in slabs. Instead, all reinforcing shall be supported on concrete cubes of the correct height. Cubes shall have a minimum compressive strength of 3,500 psi at the time of use. Supporting steel by means of cinder blocks or concrete building blocks will not be permitted.

F. Reinforcement shall be shipped to the work with bars of the same size and shape fastened in bundles with metal identification tags giving size and mark securely wired on. The identification
tags shall be labeled with the same designation as shown on submitted bar schedules and shop drawings.

G. All bars shall be stored off the ground and shall be protected from moisture and be kept free from dirt, oil, or injurious coatings.

H. Unless otherwise shown, splices in reinforcement shall be lapped not less than 24 diameters. All bar splices shall be staggered wherever possible. When splicing bars of different diameters, the length of lap is based on the larger bar.

I. Before being placed in position, reinforcement shall be thoroughly cleaned of loose mill and rust, scale, dirt, and other coatings, including ice, that reduce or destroy bond. Where there is delay in depositing concrete after reinforcement is in place, bars shall be reinspected and cleaned when necessary.

J. Reinforcement which is to be exposed for a considerable length of time after being placed shall be painted with a heavy coat of cement grout, if required.

3.03 MEASURING, MIXING, TRANSPORTING, AND PLACING CONCRETE

A. Measuring: ASTM C 94.

B. Mixing: ASTM C 94, except as modified herein. Begin mixing within 30 minutes after the cement has been added to the aggregates. If the air temperature is greater than 84 degrees, F, reduce mixing time and place concrete within 60 minutes. Additional water may be added to bring the slump within required limits as specified in Section 11.7 may be added of ASTM C 94, provided that the specified water-cement ratio is not exceeded.

C. Transporting: ACI 301

D. Placing: ACI 301, except as modified herein. Do not exceed a free vertical drop of 3 feet from the point of discharge. When placing reinforced concrete in two courses, place second course within 30 minutes of striking off first coarse.

E. Vibration: Immediately after spreading concrete, consolidate the concrete adjacent to forms and joints regardless of slab thickness, and concrete slabs 6 inches or more in thickness using internal vibrating equipment. For reinforced pavement laid in two courses, vibrate only the top course. Vibrate concrete for full depth adjacent to edge forms and joints. Limit the duration of vibration to that necessary to produce consolidation of the concrete. Excessive vibration will not be permitted. Vibrators shall not be operated in the concrete at one location for more than 15 seconds. At the option of the Contractor, vibrating equipment of a type approved by the Contracting Officer may be used to compact the concrete in unreinforced pavement slabs less than 6 inches thick.

1. Vibrating Equipment: Operate equipment, except hand-manipulated equipment, ahead of the finishing machine. Select the number of vibrating units and power of each unit to properly consolidate the concrete. Mount the units on a frame that is capable of vertical movement and, when necessary, radial movement, so the vibrators may be operated at any desired depth within the slab or be completely withdrawn from the concrete. The clear distance between frame-mounted vibrating units that have spuds that extend into the slab at intervals across the paving lane shall not exceed 30 inches. The distance between the end of the vibrating tube and the side form shall not exceed 2 inches. For pavements less that 10 inches thick, operate the vibrators at mid-depth parallel with or at a slight angle to the subbase. For thicker pavements, angle the vibrators toward the vertical, with the vibrator tip preferably about 2 inches from the subbase, and the top of the vibrator a few inches below the pavement surface. The vibrators may be pneumatic, gas driven, or the electric type, and shall be
operated at frequencies within the concrete of not less than 8,000 vibrations per minute. The amplitude of vibration shall be such that noticeable vibrations occur at 1.5-foot radius when the vibrator is inserted in the concrete to the depth specified.

F. Hot Weather: Maintain required concrete temperature in accordance with Figure 2.1.5 in ACI 305 to prevent the evaporation rate from exceeding 0.2 pound of water per square foot of exposed concrete per hour. Cool ingredients before mixing or use other suitable means to control concrete temperature and prevent rapid drying of newly placed concrete. After placement, use fog spray, spread and remove polyethylene sheeting between finishing operations, apply monomolecular film, or use other suitable means to reduce the evaporation rate. Start curing when the surface of the fresh concrete is sufficiently hard to permit during without damage. Cool underlying material by sprinkling lightly with water before placing concrete. Recommended practices may be found in ACI 305

3.04 FINISHING CONCRETE

A. General Requirements: Start finishing operations immediately after placement of concrete. Use finishing machine, except hand finishing may be used in emergencies and for concrete slabs in inaccessible locations or of such shapes or sizes that machine finishing is impracticable. Finish the surface of the pavement on both sides of a joint to the same grade. Finish formed joints from a securely supported transverse bridge. Provide hand finishing equipment for use at all times. Transverse and longitudinal surface tolerances shall be 1/4 inch in 10 feet.

B. Side Form Finishing: Strike off and screed the concrete to the required crown and cross-section by a power-driven transverse finishing machine. Transverse rotating tube or pipe shall not be permitted unless approved by the Contracting Officer. The elevation of the concrete shall be such that, when consolidated and finished, the surface of the pavement will be adequately consolidated and at the required grade. Equip the finishing machine with two screeds which are readily and accurately adjustable for changes in pavement crown and compensation for wear and other causes. Make as many passes over each area of pavement and at such intervals as necessary to give the proper compaction, retention of the coarse aggregate near the finished surface, and a surface of uniform texture, true to grade and crown. Do not permit excessive operation over an area, which will result in an excess of mortar and water being brought to the surface.

1. Equipment Operation: Maintain the travel of machine on the forms without lifting, wobbling, or other variation of the machine which tend to affect the precision of concrete finish. Keep the tops of the forms clean by a device attached to the machine. During the first pass of the finishing machine, maintain a uniform ridge of concrete ahead of the front screed for its entire length.

2. Joint Finish: Before the concrete is hardened, correct any edge slump of pavement, exclusive of edge rounding, in excess of 0.02 foot. Finish the concrete surface on each side of the construction joints to the same plane, and correct all deviations before the newly placed concrete has hardened.

3. Hand Finishing: Strike-off and screed the surface of the concrete to elevations slightly above finish grade so that when the concrete is consolidated and finished the surface of pavement is at the indicated elevation. Vibrate the entire surface until the required compaction and reduction of surface voids is secured with a strike-off template.

4. Longitudinal Floating: After the initial finishing, further smooth and consolidate the concrete by means of hand-operated longitudinal floats. Use floats that are not less than 12 feet long and 6 inches wide and stiffened to prevent flexing and warping.

C. Surface Finish: Surface finish of new pavement shall match existing.
1. **Plastic Grooving:** After surface irregularities have been removed, give the concrete surface a uniformly roughened finish by use of a wire comb or other approved texturing device similar to a wire comb. Prior to plastic grooving, make one pass with burlap drag in the longitudinal direction. Complete the grooving while the concrete surface is in such condition that it will not be torn or unduly roughened, and before the surface has obtained its initial set. Texture small or irregular areas, or areas not suitable for machine textureing, with hand operated device producing a textured surface equivalent to that required for machine combing.

2. **Edging:** At the time the concrete has attained a degree of hardness suitable for edging, carefully finish all slab edges, including the edges at formed joints, with an edge having a maximum radius of one-eighth inch. Clean by removing all loose fragments and soupy mortar from corners or edges of slabs which have crumbled and areas which lack sufficient mortar for proper finishing. Refill the voids solidly with a mixture of suitable proportions and consistency and refinish. Remove all unnecessary tool marks and edges. All remaining edges shall be smooth and true to line.

3. **Repair and Surface Defects:** ACI 301.

### 3.05 CURING AND PROTECTION

**A. General Requirements:** Protect concrete adequately from injurious action by sun, rain, flowing water, mechanical injury, tire marks and oil stains, and do not allow it to dry out from the time it is placed until the expiration of the minimum curing periods specified herein. Use impervious-sheeting curing, or liquid membrane-forming compound, except as specified otherwise herein. Do not use membrane-forming compound on surfaces where its appearance would be objectionable, on any surface to be painted, where coverings are to be bonded to the concrete, or on concrete to which other concrete is to be bonded. Maintain the temperature of the air next to the concrete above 40 degrees F for the full curing periods.

**B. Impervious-Sheeting Curing:** Wet the entire exposed surface thoroughly with a fine spray of water and then cover with impervious sheeting. Lay sheets directly on the concrete surface and overlap 12 inches. Make sheeting not less than 18 inches wider than the concrete surface to be cured, and weight down on the edges and over the transverse laps to form closed joints. Repair or replace sheets if torn or otherwise damaged during curing. Leave the sheeting on the concrete surface to be cured for at least 7 days.

**C. Liquid Membrane-Forming Compound Curing:** Seal or cover all joint openings to application of the curing compound to prevent the curing compound from entering the joint. Compound shall remain on the concrete for 7 days before sealer or covering is removed and joint sealing material is placed in the joints.

1. **Application:** Apply the compound immediately after the surface loses its water sheen and has a dull appearance and before joints are sawed. Agitate curing compound thoroughly by mechanical means during use and apply uniformly in a two-coat continuous operation by suitable power-spraying equipment. The total coverage for the two coats shall be at least one gallon of undiluted compound per 200 square feet. The compound shall form a uniform, continuous, coherent film that will not check, crack, or peel and shall be free from pinholes or other imperfections. Apply an additional coat of the compound immediately to areas where the film is defective. Respray concrete surfaces that are subject to heavy rainfall within 3 hours after the curing compound has been applied in the same manner.

2. **Protection of Treated Surfaces:** Keep concrete surfaces to which liquid membrane-forming compounds have been applied free from vehicular traffic and other sources of abrasion for not less than 72 hours. Foot traffic is allowed after 24 hours for inspection purposes. Maintain continuity of the coating for the entire curing period and repair damage to the coating immediately.
3.06 SAMPLING AND TESTING:

A. Sampling: Collect samples of fresh concrete in accordance with ASTM C 172 during each working day as required to perform all tests specified herein. Make test specimens in accordance with ASTM C 31.

B. Testing

1. Consistency Tests: Determine slump in accordance with ASTM C 143. Take samples for slump determination from the concrete while it is being placed. Perform tests at the beginning of a concrete placement operation and at subsequent intervals to ensure that the specification requirements are met. In addition, perform tests each time test beams cylinders are made.

2. Flexural Tests: Determine flexural strength in accordance with ASTM C 78. Make four test specimens for each set of tests. Test two specimens at 7 days, and the other two at 28 days. The strength of the concrete will be considered satisfactory if the average of the 28-day test results equals or exceeds the specified 28-day flexural strength, and no individual strength test is less than 700 pounds per square inch. Frequency of flexural tests on concrete beams shall not be less than four test beams for each 50 cubic yards of concrete, or fraction thereof, placed. Concrete which is determined to be defective, based on the strength acceptance criteria therein, shall be removed and replaced with acceptable concrete.

3. Air content: Test air-entrained concrete for air content at the same frequency as specified for slump tests. Determine percentage of air in accordance with ASTM C 231 on samples taken during placing of the concrete in the forms.

END OF SECTION
PART 1 - GENERAL

1.01 REFERENCE STANDARDS


B. American Society for Testing and Materials (ASTM):
   1. C33 Concrete Aggregates.
   3. C140 Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
   4. C144 Aggregate for Masonry Mortar.
   7. C270 Mortar for Unit Masonry.

C. Tile Council of North America (TCNA):

1.02 SUBMITTALS

A. General: In compliance with Section 01 33 00 and as specified herein.

B. Product Data: Manufacturer's product data for pavers indicating physical properties and compliance with criteria specified herein. Include manufacturer's written installation instructions and maintenance data for pavers. Include structural characteristics of materials furnished and descriptions of setting mortars and sealants.

C. Shop Drawings: Submit for Architect's approval prior to beginning mock-up installation.
   1. Detail drawings showing profiles, dimensions and shapes of each unit. Include details of joints and locations of control joints, connections to adjoining work and methods of installation.

D. Samples: Approved samples will be retained by Architect and establish minimum acceptable quality standards for Work.
   1. For Color, Texture and Finish: Submit minimum total of six samples, 2'-0" x 2'-0" [600 mm x 600 mm] face size by thickness required. Indicate full range of color, texture and overall finish to be expected in finished Work.

D. Letter of Conformance; (FIO): In compliance with requirements of, and in format included in, Section 01 33 00.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Protect paver materials during transportation, handling and storage.

B. Storage:
   1. Store above ground on level platforms which allow air circulation under stacked units.
   2. Cover with heavy weatherproof coverings to prevent staining by weather, dirt, mud, oils and grease.

C. Handling:
   1. Carefully handle to prevent chipping, spalling, cracking and all other damage which impairs strength, durability and appearance.
   2. Discard and remove damaged materials from Project site.
PART 2 - PRODUCTS

2.01 PAVERS

A. Basis-of-Design Manufacturer and Type: Hanover Architectural Products, Paver Systems of Georgia, “Detectable Warning Paver” 12-inch by 12-inch by 3-inch thick portland cement paver, with truncated domes, square edges, no bevels.
   1. Portland Cement: ASTM C150, Type I or Type II.
   2. Aggregates: ASTM C33, normal weight concrete aggregate. No expanded shale or lightweight aggregates.
   3. Physical Requirements:
      a. Compressive Strength: At time of delivery to Project site, average compressive strength not less than 8,500 psi.
      b. Absorption: Average rate less than 5% when tested in compliance with ASTM C140.
      c. Freeze-Thaw: Tested in compliance with ASTM C67, Section 8.
   4. Detectable warnings shall consist of raised truncated domes with diameter of nominal 0.9-inch, height of nominal 0.2-inch and center-to-center spacing of nominal 2.35-inch and shall contrast visually with adjoining surfaces, either light-on-dark, or dark-on-light.
   5. Material used to provide contrast shall be an integral part of walking surface. Contrast between detectable warning and adjacent walking surface shall be minimum 70%.

B. Other Acceptable Manufacturers: Subject to compliance with all requirements of this specification, provide named products and systems or comparable products and systems by one of following manufacturers:
   1. Paver Systems of Georgia.
   2. SupeRock Block Company.

2.02 BITUMEN SETTING MATERIALS AND ACCESSORY COMPONENTS

A. Primer for base: Anionic asphalt emulsion SS-1h, per ASTM D 977.

B. Sand for asphalt bed:
   1. Clean, non-plastic, free from deleterious or foreign matter, symmetrically shaped, natural or manufactured from crushed rock.
   2. Do not use limestone screenings, stone dust, or sand in the bedding material that does not conform to the grading requirements.
   3. Graded according to ASTM C136.
   4. Bedding Sand Material Requirements: Conform to the grading requirements of ASTM C33 with modifications as shown in Table 1.

<table>
<thead>
<tr>
<th>Table 1</th>
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<tbody>
<tr>
<td>Grading Requirements for Bedding Sand</td>
</tr>
<tr>
<td>ASTM C 33</td>
</tr>
<tr>
<td>Sieve Size</td>
</tr>
<tr>
<td>No. 4 (4.75 mm)</td>
</tr>
<tr>
<td>No. 8 (2.36 mm)</td>
</tr>
<tr>
<td>No. 16 (1.18 mm)</td>
</tr>
<tr>
<td>No. 30 (0.600 mm)</td>
</tr>
<tr>
<td>No. 50 (0.300 mm)</td>
</tr>
<tr>
<td>No. 100 (0.150 mm)</td>
</tr>
<tr>
<td>No. 200 (0.075 mm)</td>
</tr>
</tbody>
</table>

C. Asphalt cement: Heated to 300°F, 7% asphalt mixed with 93% sand in batches 145 lbs. asphalt to 1,855 lbs. sand. Determine exact proportions to produce bituminous setting bed to meet construction requirements.

D. Neoprene modified asphalt adhesive: Karnak 230 2% neo-asphalt paving block adhesive.
E. Joint Sand: Grading to conform to ASTM C144.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Acceptance of Site Verification of Conditions:
   1. Inspect that site conditions meet specifications for the following items prior to installation of interlocking concrete pavers:
      a. Verify that concrete base materials, thickness, surface tolerances and elevations conform to specified requirements.
      b. Verify location of weep holes against curbs, walls, or other permanent structures. Provide temporary plugs for holes to prevent ingress of sand-asphalt setting bed or neoprene adhesive during construction. Remove plugs when paving adjacent to drain holes.
      c. Verify that concrete surfaces to receive the bitumen bedding material are free of dust, oil, grease, paint, wax, curing compounds, primer, sealers, form release agents, from cracks over 3/16 in. in width, or any deleterious substances and debris which may prevent or reduce bonding.
      d. Conduct moisture tests to verify that concrete surfaces are cured, free from hydrostatic pressure and having a moisture content of less than 5%.
      e. Verify location, type, and elevations of edge restraints, utility structures, and drainage inlets.
      f. Do not proceed with installation of bedding sand and detectable warning pavers until base conditions are corrected.

3.02 INSTALLATION

A. Comply with the Americans with Disabilities Act (ADA).

B. Install detectable warning paver as an integral part of substrate at locations indicated in Drawings.

C. Where required, saw cut units using methods recommended by paver manufacturer. Avoid using cut pieces less than 1/2 paver width.

3.03 EDGE RESTRAINT INSTALLATION

A. Concrete edge restraints to be constructed to dimensions and level specified and shall be supported on a compacted Base not less than 6 inch thick. Concrete used for the construction of edge restraints shall be air-entrained and have a compressive strength as specified. Concrete shall be in accordance with ASTM C-94 requirements

3.04 BITUMINOUS SETTING BED APPLICATIONS

A. Tack coat should only be installed when the ambient temperature is above 50 degrees F.

B. Fill cracks under 3/16 inch wide in concrete base with mortar, and in asphalt base with bituminous bedding course material.

C. Sweep surface clean making sure not to sweep debris into the weep holes.

D. Surface of base should be thoroughly clean and dry before application. Do not apply if rain is likely before placing the bituminous setting bed.
E. Thoroughly mix tack coat in accordance with manufacturer’s recommendations based on the type of base material, then install by spraying, brushing or squeegeeing to the top of the base and to all surfaces that will be in contact with the bituminous setting bed. Once applied, tack coat should not be disturbed and should be allowed to cure or break before covering with the setting bed material.

F. Blend, hot asphalt cement with sand as recommended by manufacturer in one-ton batches and heat to a minimum of 325 degrees F. Ensure final product is a uniform mixture with all of the aggregate particles being evenly coated with asphalt cement.

G. Space area of placement such that bituminous material will remain at least 180 degrees F during compaction.

H. Screed rails should be carefully set to ensure proper setting bed depth and finished paver grade. Use 1/2-inch high x 1-1/2 inch wide steel screed rails, and adjust to proper grade using thin wooden or plastic shims under the screed rails.

I. Place bituminous material between the parallel screed bars. Pull the material with the striking board over the screed bars several times. After each passage, any voids must be filled with fresh bituminous material to provide a smooth, firm and even setting bed.

J. As soon as one area is complete, advance screed rails to the next position in readiness for screeding adjacent area. Remove any shims used, fill depressions left from removed screed rails and smooth to consistent height.

K. Roll setting bed with a roller compactor to an even, nominal thickness of 3/4-inch after compaction.

L. Re-heat, fill, and roll low areas with setting course materials to conform to slope and elevation shown on Drawings. Re-heat, remove, level, and roll setting bed in high areas to conform to slope and elevation shown on Drawings.

M. Irregularities or evenness in the grade of the concrete base surface may be corrected with setting bed materials only with approval by the Architect.

N. Extend structural joints through full depth of bituminous setting bed by installing pre-molded joint filler.

O. After the Bituminous Setting Bed has cooled, thoroughly mix the asphalt adhesive and apply a 1/32 inch (maximum) coating over the entire bituminous setting bed by either; using a notched trowel with serrations as per the recommendations of manufacturer or squeegeeing.

P. Do not apply concrete pavers to adhesive until dry skin forms on surface of adhesive.

Q. Only apply as much adhesive as can be covered before the end of the day.

3.05 PAVER INSTALLATION

A. Ensure concrete pavers are free of foreign material before installation. Inspect for color distribution and remove chipped, damaged or discolored pavers.

B. Lay pavers firmly onto adhesive following pattern shown on Drawings. Maintain straight pattern lines. Ensure color blending.

C. Joints between individual concrete pavers, and between concrete pavers and the edge restraints, buildings, collars, or other protrusions/edging, shall be between 1/16 inch wide.

D. Fill gaps at edges of paved area with cut pavers or edge units. Do not install cut pavers smaller than one-third of a whole paver in areas subject to vehicular traffic, follow manufacturer’s recommendations.
E. Extend structural joints through full depth of paving units and bituminous setting bed by installing pre-molded joint filler as units are set in the bituminous bed. Maintain top of filler 3/8 inch below exposed face of paving units for insertion of sealant.

F. Fully compact the pavers into place.

G. Install joint sealant at the structural joints.

H. Once pavers, joint filler and sealant are installed, spread joint filling sand and fill joints between pavers. Vibrate joint filling sand into joints. Top up joints as required. Sweep off excess sand when the job is complete.

3.04 TOLERANCES

A. Allowable Installation Tolerances: Maintain lines and grades to following:
   1. Lines and Levels: Within 1/8-inch in 10'-0".
   2. Maximum Height Variation Between Adjacent Pavers: 1/16-inch.

3.05 CLEANING AND PROTECTING

A. Remove stains, excess materials and debris as Work progresses.

B. Clean pavers using stiff bristle brushes and clean water.

C. Keep pavers free of debris until Date of Substantial Completion.

END OF SECTION
SECTION 32 31 13

CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.01 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM):
   1. A36/A36M Carbon Structural Steel.
   2. A53/A53M Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
   3. A392 Zinc-Coated Steel Chain-Link Fence Fabric.
   5. F567 Practice for Installation of Chain-Link Fence.
   6. F668 Poly (Vinyl Chloride) (PVC) and Other Organic Polymer-Coated Steel Chain-Link Fence Fabric.
   7. F934 Standard Colors for Polymer-Coated Chain Link Fence Materials.
   8. F969 Practice for Construction of Chain-Link Tennis Court Fence.

B. Chain Link Fence Manufacturers Institute (CLFMI):
   1. CLF2445 Product Manual.
   2. WLG2445 Guide for Selection of Line Post Spacings for Chain Link Fence.

1.02 SUBMITTALS

A. General: In compliance with Section 01 33 00 and as specified herein.

B. Product Data:
   1. Manufacturer's technical data, specifications, and installation instructions for fence and gate posts,
      fabric, gates, and accessories.
   2. Up-to-date, full range of PVC coating colors available.

C. Product Certificates; (FIO): Signed by manufacturer of chain link fences and gates certifying that
   products furnished comply with requirements.

D. Letter of Conformance; (FIO): In compliance with requirements of, and in format included in, Section
   01 33 00.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who has minimum three years' experience and
   has completed minimum five chain link fence projects with same material and of similar scope to that
   indicated for this Project with successful construction record of in-service performance.

B. Single-Source Responsibility: Obtain chain link fences and gates, including accessories, fittings, and
   fastenings, from single source.
PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with all requirements of this specification, provide named products and systems or comparable products and systems by one of following manufacturers:
   1. Allied Fence Company Inc.
   2. American Fence.
   4. USX Corporation Cyclone Fence Division.
   5. Semmerling Fence & Supply, Inc.

2.02 FENCING

A. Fabric: ASTM A392, Class 1, 2-inch diamond mesh, interwoven, 0.148-inch diameter (9 gauge) wire, knuckled on both selvages, hot-dip galvanized 1.2 oz./sq.ft.
   1. Vinyl Coated Wire: ASTM F668, Class 2b, fused PVC in color of black.

B. Posts and Rails: ASTM F1083; Schedule 40 steel pipe, complying with ASTM F669, Group IA, with minimum yield strength of 25,000 psi, hot-dip galvanized with not less than 1.8 oz. zinc coating per square foot of interior and exterior surface area, of following nominal outside diameters.
   1. Line Posts: 2.38-inches diameter.
   2. End, Corner and Terminal Posts: 4.0-inches diameter.
   3. Gate Posts: 4-inch diameter.
   4. Top and Brace Rail: 1.66-inch diameter, plane end, sleeve coupled, Type I steel pipe.
   5. Gate Frame: 1.90-inch diameter.

C. Caps: Pressed steel, or malleable iron, hot-dip galvanized, sized to post dimensions, set screw retained.

D. Fittings: Malleable cast iron or pressed steel sleeves, bands, clips, rail ends, tension bars, fasteners and fittings; all hot-dip galvanized.
   1. 3/16-inch x 3/4-inch stretcher bars; 2-inches less in length than fabric. Provide one stretcher bar at each gate and end post; two at each corner and pull post.
   2. 7/8-inch brace and tension bands.
   3. 3/8-inch diameter truss braces; high carbon steel with turnbuckle.

E. Bottom Tension Wire: 7 gauge aluminized steel single strand, vinyl clad.

F. Tie Wires: 9 gauge aluminized steel.

G. Anchoring Cement: ASTM C1107, quick setting, self leveling, pourable cement base; waterproof, non shrink Exterior erosion-resistant anchoring cement.
   1. Adhesives Technology "Hard-Rok".
   2. BASF, "MasterFlow 110 AN".
   3. ProSpec "High Strength Precision Grout".
   4. Five Star Products, Inc., "Five-Star Grout".

H. Gates: Welded construction with adjustable, diagonal cross bracing. Provide following hardware for gates:
   1. Hinges: Steel or malleable iron of size to suit gate size, nonlift off type, offset to allow 180 degree operation. Furnish one pair of hinges per leaf.
   2. Latch for Pass Leaf Gate: Forked type with center drop rod, integral padlock eye, complete with keeper to receive padlock.
   3. Stops: Mushroom type at double leaf gates; to engage drop rod.

I. Sleeves: ASTM A53, Schedule 40 galvanized steel pipe, 12-inches long by inside diameters required to provide approximately 1/4-inch space for anchoring cement around perimeter of posts.
J. Concrete: ASTM C94, normal, portland cement, 3000 psi 28-day, 2-inch to 3-inch slump.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install chain link fence in compliance with applicable provisions of CLFMI "Standards for Chain Link Fence Installation", and ASTM F567 and ASTM F969.
   1. Maximum Spacing of Posts: CLFMI Standard; space line posts maximum 10'-0" o.c. uniformly between corners and ends.

B. Install line posts, corner posts, top rails, post caps, fabric and gates, to provide rigid structure for fence of height indicated. Use manufacturer’s standard fittings, fasteners and hardware.

C. Provide line post holes not less than 9-inches in diameter x 2'-6" deep; provide other post holes 12-inches in diameter x 3'-0" deep. Set posts plumb and true in 3000 psi concrete. Crown concrete surface to shed water. Set sleeves in concrete minimum 2'-0" deep. Set all posts in anchoring cement.

D. Position bottom of fabric 2-inches above finished grade with tension wire stretched taut between posts.

E. Brace end, corner, pull and gate post with horizontal intermediate brace and truss braces.

F. Install top rail continuous with couplings not less than 6-inches long.

G. Install fabric on exterior of enclosed space. Stretch fabric taut allowing approximately 1-inch clearance at grade. Fasten to line posts and top rail with ties; all other posts with stretcher bars. Tie fabric to post at 1'-0" o.c.; top rail at 2'-0" o.c. Fabric shall not by-pass end, gate, corner or pull posts.

H. Join fabric lengths by weaving single strand into roll ends to form continuous length.

I. Install gates complete with specified hardware at locations indicated. Adjust and lubricate hardware.

J. Protect surfaces from damage until Date of Substantial Completion. Replace components damaged during installation.

K. Provide concrete center rest and drop bolt retainers at center of double gate openings.

END OF SECTION
SECTION 32 92 19

SEEDING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, equipment and incidentals necessary and place seed and maintain all seeded areas as shown on the Drawings and as specified herein including all areas disturbed by the Contractor's operations.

1.02 RELATED WORK

A. Division 31: Site Preparation

B. Division 31: Earth Excavation and backfill including the stockpiling of topsoil

PART 2 - PRODUCTS

2.01 MATERIALS

A. Fertilizer shall be a complete commercial fertilizer. It shall be delivered to the site in the original unopened containers each showing the manufacturer's guaranteed analysis. Store fertilizer so that when used it shall be dry and free flowing.

B. Lime shall be ground limestone containing not less than 85 percent calcium and magnesium carbonates.

C. Seed shall be from the same or previous year's crop; each variety of seed shall have a percentage of germination not less than 90, a percentage purity of not less than 85, and shall have not more than one percent weed content.

D. The mixture for lawn areas shall consist of seed proportioned by weight as indicated on the drawings.

E. Seed shall be delivered in sealed containers bearing the dealer's guaranteed analysis.

PART 3 - EXECUTION

3.01 APPLICATION

A. Lime shall be applied at the rate as shown on the drawings.

B. Fertilizer shall be applied at the rate as shown per the drawings.

3.02 INSTALLATION

A. The subgrade of all areas to be seeded shall be raked and all rubbish, sticks, roots and stones larger than 2 inches shall be removed.
B. Lime shall be spread evenly over surface and thoroughly incorporated with loam by heavy raking to at least 2 inches deep.

C. Fertilizer shall be uniformly spread and immediately mixed with the upper 2 inches of the soil.

D. Immediately following this presentation the seed shall be uniformly applied and lightly raked into the surface. Lightly roll the surface and water with a fine spray. Seed shall be sown in a favorable season, as approved by the Owner's representative.

E. The Contractor shall keep all seeded areas watered and in good condition, if and when necessary until a good, healthy, uniform growth is established over the entire area seeded, and shall maintain these areas in an approved condition until final acceptance of the Contract.

F. On slopes, the Contractor shall provide against washouts. Any washout which occurs shall be re-graded and re-seeded at the Contractor's expense until good sod is established.

G. The Contractor shall maintain the areas in grass in a neat manner by watering, mowing, raking clippings and leaves, and appurtenances until the project is completed.

END OF SECTION
SECTION 33 30 00
DIP FOR SANITARY SEWERS

PART 1 - GENERAL

1.01 SCOPE OF WORK
A. The Contractor shall supply all labor, equipment, materials and incidental necessary to install all piping and appurtenances as specified herein.
B. Furnish all excavation, backfilling, sheeting, slope protection, drainage, concrete work, rip rap, grading and all other work necessary to complete the construction, installation and testing of the piping.

1.02 RELATED WORK
A. Division 31: Excavation, Backfill, Fill and Grading.
B. Division 31: Bore and Jack Casings

1.03 SUBMITTALS
A. Submit shop drawings showing a complete laying plan of all pipe, including all fittings, adapters, valves and specials along with the manufacturer’s drawings and specifications indicating complete details of all items. The above shall be submitted for approval before fabrication and shipment of these items. The locations of all pipes shall conform to the locations indicated in the drawings. In most cases, a certain amount of flexibility in positioning of pipes will be allowed, especially where new pipes will connect to existing structures or piping.

1.04 INSPECTION
A. All pipe and fittings to be installed under this Contract may be inspected at the site of manufacture for compliance with these Specifications by an independent laboratory selected by the Owner.

1.05 APPROVAL OF MATERIALS
A. Submit to the Engineer for approval, within thirty (30) days after the Notice to Proceed, a listing, including materials to be furnished, the name of the suppliers, the date of delivery of materials to the job site, and a time schedule for the completion of the project.

PART 2 - PRODUCTS

2.01 MATERIALS
A. Ductile iron pipe shall meet the following requirements:
   1. Ductile iron pipe shall conform to ANSI/AWWA C151/A21.51-91. A minimum of Class 52 pipe shall be supplied for all sizes of pipe unless specifically called out in the drawings. Thickness of pipe to be supplied shall be one (1) class greater than that required under Table 51.1 AWWA C151 (ANSI 21.51). Type 1 Bedding Conditions shall be used for all diameters.
2. The pipe shall be supplied in length not in excess of 20 feet. Pipe shall be either the rubber-ring type push-on joints, standard mechanical joint pipe or restrained joint where required. Ball joint pipe and flange joint pipe shall be used where shown on the drawings. Pipe shall be as manufactured by the American Ductile Iron Pipe Company, U.S. Pipe and Foundry Company, Clow Corporation, or McWayne Pipe Foundry.

B. All ductile iron pipe fittings shall be cast iron or ductile iron with a minimum pressure rating of 150 psi. Fittings shall meet the requirements of ANSI, NEWWA, and AWWA specifications as applicable. Rubber gasket joints shall conform to ANSI A21.11 for mechanical and push-on type joints. Ball joints shall conform to ANSI A21.51, with a separately cast ductile iron bell conforming to ASTM A536, Grade 70-5-05, and a cast steel retainer ring conforming to ASTM A148, Grade 90-60.

PART 3 - EXECUTION

3.01 HANDLING PIPE AND FITTINGS

A. Care shall be taken in loading, transporting and unloading to prevent injury to the pipe or coatings. Pipe or fittings shall not be dropped. All pipe for fittings shall be examined before laying, and no piece shall be installed which is found to be defective. Any damage to the pipe coatings shall be repaired.

B. All pipe and fittings shall be subjected to a careful inspection and hammer test just prior to being laid or installed.

C. If any defective pipe is discovered after it has been laid it shall be removed and replaced with a sound pipe in a satisfactory manner at no additional expense to the Owner. All pipe and fittings shall be thoroughly cleaned before laying, shall be kept clean until they are used in the work, and when installed or laid, shall conform to the lines and grades required.

3.02 DUCTILE IRON PIPE

A. Ductile iron pipe and fittings shall be installed in accordance with requirements of AWWA Standard Specification C600 except as otherwise provided herein. A firm, even bearing throughout the length of the pipe shall be constructed by tamping selected material at the sides of the pipe up to the springline. BLOCKING WILL NOT BE PERMITTED.

B. All pipe shall be sound and clean before laying. When laying is not in progress, including lunch time, the open ends of the pipe shall be closed by watertight plug or other approved means. Good alignment shall be preserved in laying. The deflection at joints shall not exceed that recommended by manufacturer. Fittings, in addition to those shown on the plans, shall be provided, if required, in crossing utilities which may be encountered upon opening the trench.

C. When cutting pipe is required, the cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. Cut ends of pipe to be used with a Tyton bell shall be beveled to conform to the manufactured spigot end. Cement lining shall be undamaged.

D. Jointing Ductile-Iron Pipe:
1. Push-on joints shall be made in strict accordance with the manufacturer's instructions. Pipe shall be laid with bell ends looking ahead. A rubber gasket shall be inserted in the groove of the bell end of the pipe, and the joint surfaces cleaned and lubricated. The plain end of the pipe to be entered shall then be inserted in alignment with the bell of the pipe to which it is to be joined, and pushed home with a jack or by other means. After joining the pipe, a metal feeler shall be used to make certain that the rubber gasket is correctly located.

2. Mechanical joints at valves, fittings and where designated on the drawings and/or as specified shall be in accordance with the "Notes On Method of Installation" under ANSI Specification A21.11 and the instructions of the manufacturer. To assemble the joints in the field, thoroughly clean the joint surfaces and rubber gasket with soapy water before tightening the bolts. Bolts shall be tight to the specified torque. Under no condition shall extension wrenches or pipe over handle or ordinary ratchet wrench be used to secure greater leverage.

3.03 CLEANING OF SANITARY SEWER SYSTEMS

A. Cleaning of new sewer lines shall be done by the Contractor prior to final inspection by the City.

B. Sanitary sewers shall be thoroughly cleaned using a hydro-jet or similar sewer cleaning device in a manner as not to impair or damage an existing tie-in system.

C. It is the Contractor's responsibility to maintain a clean system throughout all phases of testing.

3.04 LOW-PRESSURE AIR TESTING OF SANITARY SEWERS

A. All new sewer lines shall be tested for leakage using low-pressure air testing.

B. Air testing shall be done in accordance with ASTM C828 except as herein modified or directed. Sewers constructed using PVC pipe shall be subject to air testing meeting the requirements of Uni-Bell PVC Pipe Association UNI-B-90.

C. The line segment between two manholes shall be temporarily plugged using airtight fittings through which low-pressure air can be introduced.

D. All wyes, tees, and stubs shall be plugged in a manner acceptable to the Inspector. The plugs shall be securely fastened to withstand internal test pressures. Plugs shall be readily removable to provide a suitable future house connection or extension.

E. The procedure for determining the amount of leakage by low pressure testing shall be as stipulated by the Inspector.

F. Low-pressure air will be introduced into the test pipe segment until the internal air pressure reaches 3.5 psig above ground water pressure, if any.

G. Where high ground water is known to exist, the height in feet of ground water above the invert of the sewer shall be divided by 2.31 to establish the pounds of pressure that shall be added to the internal air pressure used during the test.

H. At least two minutes will be allowed for air temperature in the test segment to stabilize while internal air pressure remains no less than 3.5 psig above groundwater pressure.

I. Internal air pressure will be deflated to exactly 3.5 psig above groundwater pressure.
J. The elapsed time for internal pressure to drop to 2.5 psig above ground water pressure will be accurately determined. If it is obvious to the Inspector that no leakage is occurring, he may terminate the test early.

K. The air test is acceptable if the elapsed time is not less than shown in the table shown below.

<table>
<thead>
<tr>
<th>Pipe Diameter</th>
<th>Minutes/100 feet</th>
<th>Elapsed Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-inch</td>
<td></td>
<td>1.2</td>
</tr>
<tr>
<td>10-inch</td>
<td></td>
<td>1.5</td>
</tr>
<tr>
<td>12-inch</td>
<td></td>
<td>1.8</td>
</tr>
<tr>
<td>15-inch</td>
<td></td>
<td>2.1</td>
</tr>
<tr>
<td>18-inch</td>
<td></td>
<td>2.4</td>
</tr>
<tr>
<td>21-inch</td>
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<td>3.0</td>
</tr>
<tr>
<td>24-inch</td>
<td></td>
<td>3.6</td>
</tr>
<tr>
<td>27-inch</td>
<td></td>
<td>4.2</td>
</tr>
<tr>
<td>30-inch</td>
<td></td>
<td>4.8</td>
</tr>
</tbody>
</table>

L. If the installation fails to meet the requirements of this test, the Contractor shall determine the source of leakage. He shall repair or replace all defective materials and/or workmanship. The installation will then be re-tested for compliance with these specifications.

END OF SECTION
SECTION 33 40 00
REINFORCED CONCRETE PIPE FOR STORM DRAINS

PART 1 - GENERAL

1.01 SCOPE OF WORK
A. Furnish all labor, materials, equipment and incidentals necessary to install reinforced concrete pipe and fittings as shown on the drawings and required by the Specifications.

1.02 SHOP DRAWINGS
A. Submit shop drawings showing piping and drainage structure layout and details of reinforcement, joint and method of construction and installation of reinforced concrete pipe, specials, and fittings required.

1.03 RELATED WORK
A. Division 31: Excavation, Backfill, Fill and Grading for Pipe
B. Division 32: Concrete

PART 2 - PRODUCTS

2.01 REINFORCED CONCRETE PIPE
A. Except as otherwise specified within, pipe shall conform to ASTM Standard Specifications for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe, Designation C76, Class III, Wall B. The tabulated reinforcement given in the tables in ASTM Standard C76 shall be the minimum required.
B. The pipe shall be capable of withstanding construction equipment loading which may be encountered during the progress of work. Any pipe damage during construction operations shall be promptly and satisfactorily repaired.
C. Non-air-entraining Portland cement conforming to ASTM Specification C150, Type I shall be used, except as otherwise approved in writing. The use of a non-bleeding, water-reducing, dispersing agent may be permitted subject to the specific approval. The use of any other admixture will not be permitted.
D. Fine aggregate shall consist of washed inert natural sand conforming to the requirements of ASTM Specification C33, except for gradation, with a maximum loss of 5% when subjected to 5 cycles of the soundness test using magnesium sulfate.
E. Coarse aggregate shall consist of well-graded crushed stone or washed gravel conforming to the requirements of ASTM Specification C33, with a maximum loss of 5% when subjected to 5 cycles of the soundness test using magnesium sulfate.
F. The 28-day compressive strength of the concrete, as indicated by cores cut from the pipe shall be not less than 4,000 psi. The pipe interior shall comprise a continuous integral cement skin and shall be smooth and even, free from roughness, projections, indentations, offsets or irregularities. The concrete mass shall be dense and uniform.
The average absorption shall not exceed 5.3%. Reinforcement shall be circular for all concrete pipe. Reinforcement in the bell and spigot shall be adequate to prevent damage to concrete during shipping, handling and installation. Cores indicating reinforcing steel having less than 85% bond shall be cause for rejection of the lot of pipes.

G. The pipe shall be clearly marked as required by ASTM C76. The markings may be at either end of the pipe for the convenience of the manufacturer, but for any one size shall always be at the same end of each pipe length. Pipe shall not be shipped until compressive strength of the concrete has attained 3,000 psi and not before 5 days after manufacture and/or repaired, whichever is the longer.

H. Pipes shall have a minimum laying length of approximately 8', except for closure and other special pieces. The length of the incoming and outgoing concrete pipe at each structure shall not exceed 4', except where the joint is cast flush with the exterior wall of the structure. Maximum laying length shall not exceed 16', but the installation of 16' lengths will depend upon the ability of the Contractor to handle such lengths of pipe. In deep sheeted trenches comply with trench width requirements, maintain the integrity of the sheeting and avoid disturbance to adjacent ground. If in the opinion of the Owner's Representative the use of 16' lengths is impracticable, shorter lengths shall be used.

I. The quality of all materials and the finished pipe shall be subject to inspection and approval of a representative of the Owner. Such inspection may be made at both places, and the pipe shall be subject to rejection at any time because of failure to meet any of the specification requirements, even though sample pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall be removed from the job at once.

J. At the time of inspection, the pipe will be carefully examined for compliance with the appropriate ASTM and project specification, and inspected for general appearance, dimension, "scratch-strength", blisters, cracks, roughness, soundness, and other features. All pipes will be checked for soundness by being tapped and scratched over a reasonable portion of the area, at least once on every 20 sq. inches of pipe surface. The surface shall be dense and close-textured. Cores shall also serve as a basis for rejection of pipe, particularly if lamination or poor bond of reinforcement is apparent.

K. The manufacturer shall inspect all pipe joints for out-of-roundness and pipe ends for squareness. The manufacturer shall furnish a notarized affidavit stating all pipes meet the requirements of ASTM C76, these specifications, and the joint design with respect to square ends and out-of-round joint surfaces.

L. Unsatisfactory or damaged pipe will be either permanently rejected or returned for minor repairs. Only that pipe actually conforming to the specifications and accepted will be listed for approval, shipment and payment. Approved pipe will be so stamped or stenciled on the inside before it is shipped. All pipe which has been damaged after delivery will be rejected, and if such pipe already has been laid in the trench, it shall be acceptably repaired, if permitted, or removed and replaced.

M. Pits, blisters, rough spots breakage and other imperfections may be repaired, subject to the approval of the Owner's Representative, after demonstration by the manufacturer that strong permanent repairs result. Repairs shall be carefully inspected before final approval. Non-shrink cement mortar used for repairs shall have a minimum compressive strength of 6,000 psi at the end of 7 days and 7,000 psi at the end of 28 days, when tested in 3" cylinders store in the standard manner. Epoxy mortar may be utilized for repairs.
2.02 JOINTS FOR CONCRETE PIPE

A. Joints for concrete pipe shall be the tongue and groove or bell and spigot type of joint with provisions for using a round rubber "0-Ring" gasket in recess in the spigot end of the pipe. The bevel on the bell of the pipe shall be between 1-1/2 degree and 2-1/2 degree and the annular open spaced at the gasket when the joint is made up and pipes are centered in line shall not exceed 1/8". The faces of pipe in contact with the gasket shall be true, and free of irregularities. Joints for drain pipe may be made with mortar.

B. The round rubber "0-Ring" gaskets for either joint shall conform to ASTM C443 Specifications for joints for Circular Concrete Sewer and Culvert Pipe using rubber gaskets.

PART 3 - EXECUTION

3.01 LAYING REINFORCED CONCRETE PIPE FOR DRAINS

A. Bell and spigot pipe joints shall be made by caulking all around with twisted jute of proper size to give proper alignment of the pipe. Inner surfaces of abutting sections shall be flush and on a smooth grade. Brush and wet the jointing surfaces and fill the annular opening with mortar to a minimum depth of 2", sufficient to form a bead around the outside face of the bell.

B. Mortar for jointing shall consist of one part Portland cement and two parts sand, using a minimum amount of water-sufficient to make a workable mortar.

C. Joints shall be immediately protected from freezing or excessive drying by covering with earth, burlap or other approved material.

3.02 CLEANING

A. At the conclusion of the work, thoroughly clean all of the new pipe lines by flushing with water or other means to remove all dirt, stones, pieces of wood or other material which may have entered during the construction period. Debris cleaned from the lines shall be removed from the lowest outlet. If, after this outlet cleaning, obstructions remain, they shall be removed.

END OF SECTION
SECTION 33 49 00
DRAINAGE STRUCTURES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install in the locations as shown on the Drawings, the drainage pipe, catch basins, headwalls and appurtenances as specified herein.

B. All drainage structures shall be manufactured and installed in accordance with details included herein, and as shown on Drawings.

1.02 RELATED WORK

A. Excavation and Backfill for pipe; Division 31.

B. Reinforced concrete pipe for Storm Drains; Division 33.

C. Concrete and Reinforcing Steel; Division 3.

1.03 QUALIFICATIONS

A. All precast structures shall be furnished by a single manufacturer who is fully experienced, reputable, and qualified in the manufacture of items to be furnished. The structures shall be designed, constructed, and installed in accordance with the best practices and methods and shall comply with these Specifications.

1.04 SUBMITTALS

A. Submit for approval six (6) sets shop drawings showing details of construction, reinforcing, joints and catch basin connections.

1.05 INSPECTION

A. The quality of all materials, the process of manufacture, and the finished sections shall be subject to inspection and approval or other representative of the Owner. Such inspection may be made at the place of manufacture, or on the work after delivery, or at both places, and the sections shall be subject to rejection at any time on account of failure to meet any of the Specification requirements, even though sample section may have been accepted as satisfactory at the place of manufacture. Sections rejected after delivery to site shall be marked for identification and shall be removed from the site at once. All sections which have been damaged after delivery will be rejected, and if already installed, shall be acceptably repaired, if permitted, or removed and replaced, entirely at the Contractor's expense.

B. At the time of inspection, the sections will be carefully examined for compliance with the ASTM designation specified below and these Specifications, and with the approved manufacturer's drawings. All sections shall be inspected for general appearance, dimension, "scratch-strength", blisters, crack, roughness, soundness, etc. The surface shall be dense and close-textured.
C. Imperfections may be repaired, subject to the approval of the Engineer, after demonstration by the manufacturer that strong and permanent repairs result. Repairs shall be carefully inspected before final approval. Cement mortar used for repairs shall have a minimum compressive strength of 4,000 psi at the end of 7 days and 5,000 psi at the end of 28 days, when tested in 3” x 6” cylinders stored in the standard manner. Epoxy mortar may be utilized for repairs subject to the approval of the Owner’s representative.

PART 2 - PRODUCTS

2.01 MATERIALS AND DESIGN

A. Precast structures shall conform to ASTM Designation C478 and meet the following additional requirements:
   1. Type II cement shall be used except as otherwise approved.
   2. Holes to accommodate pipe shall be precast into the section at the foundry.
   3. All sections shall be cured by an approved method and shall not be shipped nor manhole rungs subjected to loading until the concrete compressive strength has attained 3,000 psi and not before 6 days after fabrication and/or repair, whichever is the longer.
   4. Precast concrete top slabs shall be designed for an H-20 wheel loading.
   5. The date of manufacture and the name or trademark of the manufacturer shall be clearly marked on the inside on each precast unit.
   6. Minimum wall thickness shall be 5”.
   7. Minimum inside diameter shall be 48”.
   8. The precast reinforced base shall be a minimum of 6” thick and be cast monolithically with the bottom section of manhole walls.
   9. Catch basin sections shall be jointed with either an O-ring type joint or a tongue and groove joint complete with flexible plastic gasket. The O-ring type joints shall be round compression ring of neoprene material set in annular spaces cast into the spigot end of a bellspigot type joint. The ring shall be uniformly compressed between the positioned sections so as to form a watertight joint. After the sections are assembled, the remaining space in the joint shall be point up and filled with a dense cement mortar and finished so as to make a smooth, continuous surface inside and outside the wall sections. The tongue and groove joint shall be sealed with a flexible plastic gasket as manufactured by K.T. Snyder and Sons or approved equal. After the manhole sections have been assembled, the gasket shall completely fill the joint.
   10. If the Owner feels the precast sections do not meet the Specification, the Owner shall require the sections to be tested by a certified testing laboratory. The Owner shall pay for the test if the test shows the Specifications are met and the Contractor shall pay for the tests if the test shows the Specifications are not met.

B. Base unit, reducer slabs and flat top slabs shall have steel reinforcement as shown in details.

C. Openings for pipes larger than six (6) inches in diameter are to be precast. A minimum of six (6) inches between the circumference is to remain between any two holes.

D. The Contractor will furnish the fabricator with the angle of alignment and size of all pipes to enter manhole and the height of structure.

E. Base units shall have sufficient height to allow for minimum of six (6) inches of wall between top of highest opening for pipes and bottom of joint.

F. Pipes are to be extended into structure wall a minimum of four (4) inches, but should not extend beyond interior wall of structure.
PART 3 - EXECUTION

3.01 INSTALLATION

A. Catch basins shall be constructed to the dimensions shown on the Drawings and as specified in these Specifications.

B. Precast concrete sections shall be set so as to be vertical and with sections in true alignment with a 1/4" maximum tolerance to be allowed. The outside and inside joint shall be filled with a comparatively dry mortar (one part cement and two parts sand) and finished flush with the adjoining surfaces. Allow joints to set for 24 hours before backfilling. Backfilling shall be done in a careful manner, bringing the fill up evenly on all sides. If any leaks appear in the catch basins, the inside joints shall be caulked with lead wool. The Contractor shall install the precast sections in a manner that will result in a watertight joint.

C. Holes in the concrete pipe sections required for handling or other purposes shall be plugged with a non-shrinking grout or by grout in combination with concrete plugs.

D. Where holes must be cut in the precast sections to accommodate pipes, cutting shall be done prior to setting them in place to prevent any subsequent jarring which may loosen the mortar joints.

E. The precast concrete base shall be placed on a bed of crusher-run gravel as shown on the Drawings to provide even bearing and grade control.

F. Catch basin pipe connections:
   1. A tapered hole filled with non-shrink waterproof grout after the pipe is inserted is acceptable, providing the grout is placed carefully to completely fill all around the pipe. If this method is used, place concrete encasement around the stub.

G. Cast iron frames specified and furnished under Division 5 shall be placed, shimmed and set in Portland Cement mortar to the required grade.

H. The catch basin inverts, or channels shall be so constructed as to permit a smooth transition between the up and downstream lines or pipes. The lines or pipes entering the manhole shall be laid to the grade shown on the Drawings. Channels shall be constructed of cement grout and shall be shaped as shown on the Drawings and troweled to render a smooth finish.

END OF SECTION