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<th>Description</th>
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SECTION 21 0553

IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   4. Stencils.
   5. Valve tags.
   6. Warning tags.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Samples: For color, letter style, and graphic representation required for each identification material and device.
C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
D. Valve numbering scheme.
E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
B. Coordinate installation of identifying devices with locations of access panels and doors.
C. Install identifying devices before installing acoustical ceilings and similar concealment.
PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Brady Corporation.
      2. Marking Services, Inc.

2.2 EQUIPMENT LABELS
   A. Plastic Labels for Equipment:
      1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
      2. Letter Color: Black.
      3. Background Color: Background to contrast with letter color.
      4. Maximum Temperature: Able to withstand temperatures up to 160°F.
      5. Minimum Label Size: Length and width vary for required label content, but not less than 4 inches wide by 1-1/2 inches high.
      6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
      7. Fasteners: Stainless-steel rivets or self-tapping screws.
      8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
   B. Label Content: Include equipment’s Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Section number and title where equipment is specified.
   C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.3 WARNING SIGNS AND LABELS
   A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
   B. Letter Color: Black.
   C. Background Color: Background to contrast with letter color.
   D. Maximum Temperature: Able to withstand temperatures up to 160°F.
E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.4 STENCILS FOR PIPING

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.


2. Paint: Standardized colors for the entire piping system shall be painted per Division 09 painting specification. Paint material is based on colors and model numbers manufactured by Glidden unless otherwise indicated. Subject to compliance with requirements, provided named color or comparable product as approved. Use the following colors for banding of all piping and conduit:

<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>COLOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire-Suppression</td>
<td>Red</td>
</tr>
</tbody>
</table>

3. Standardized Sizes: Tags shall be at least 1-1/2 inches in diameter, with depressed block characters 1/4 inch high. Titles shall be lettered on bands. Uppercase letters and Arabic numerals shall be used. Where pipes or conduits are too small or not readily accessible for such application securely fasten a brass identification tag at appropriate locations. Identification of the material contained in piping and conduits in accordance with the table below:

<table>
<thead>
<tr>
<th>Outside Diameter of Pipe Covering</th>
<th>Width of Color Band</th>
<th>Size of Letters and Numerals</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 to 1-1/4</td>
<td>8</td>
<td>1/2</td>
</tr>
<tr>
<td>1-1/2 to 2</td>
<td>8</td>
<td>3/4</td>
</tr>
<tr>
<td>2-1/4 to 3-1/4</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>3-1/2 to 6</td>
<td>12</td>
<td>1-1/4</td>
</tr>
<tr>
<td>8 to 10</td>
<td>24</td>
<td>2-1/2</td>
</tr>
<tr>
<td>Over 10</td>
<td>32</td>
<td>3-1/2</td>
</tr>
</tbody>
</table>
4. Pipe Identification: Identify pipe at wall penetrations, machine or tank connections, and at not over 20 foot intervals. Marker identification should be visible from the floor. Mark each pipe circuit with stencil. Stencil shall include flow arrow and identification marks as follows:

<table>
<thead>
<tr>
<th>SERVICE</th>
<th>MARK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire</td>
<td>Fire</td>
</tr>
</tbody>
</table>

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4 inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass S-hook.

B. Valve Schedules: For each piping system, on 8-1/2 by 11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: 3 inches by 5-1/4 inches minimum.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Equipment to be identified with plastic nameplates includes but is not limited to sprinkler alarm valve assemblies, backflow preventers, etc.

B. Identify valves with tags.
3.3 EQUIPMENT LABEL INSTALLATION
   A. Install or permanently fasten labels on each major item of equipment.
   B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION
   A. Piping Color-Coding: Painting of piping is specified in Division 09 painting sections – All pipe identification shall be stenciled legibly on pipe.
   B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
      1. Near each valve and control device.
      2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
      3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
      4. At access doors, manholes, and similar access points that permit view of concealed piping.
      5. Near major equipment items and other points of origination and termination.
      6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

3.5 VALVE-TAG INSTALLATION
   A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units.
   B. List tagged valves in a valve schedule in aluminum frame with clear plastic shield. Install at location as directed by Owner’s Representative.

3.6 WARNING-TAG INSTALLATION
   A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION
SECTION 21 1300
FIRE PROTECTION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Conditions of the Contract and applicable requirements of Division 1, General Requirements, and Section 22 0500, Common Work Results for Plumbing, govern this Section.

B. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner’s operation and maintenance personnel, is required in cooperation with the Owner’s Representative and the Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation and issue closure. Refer to Section 01 9113, General Commissioning, for detailed commissioning requirements.

1.2 DESCRIPTION OF WORK

A. Work Included: Provide a complete building fire protection standpipe and sprinkler system in compliance with these Specifications.

B. Types: The types of fire protection systems shall include, but is not limited to, the following:

1. The building fire protection system shall consist of a complete sprinkler system served from a manual Class 1 combination standpipe system in accordance with NFPA 13, NFPA 14 and the requirements of the State Fire Marshall.

2. Conditioned areas of the building shall be protected with a wet-pipe sprinkler system as specified in Section 21 1313, Wet-Pipe Fire Sprinkler System.

C. Provide riser control valves and sprinkler zone control valve test assemblies with valve tamper switches, as required.

D. Basic Materials and Methods: Refer to Section 22 0500, Common Work Results for Plumbing, for additional fire protection piping system requirements.

E. Vibration Isolation: Refer to Section 22 0548, Vibration Isolation for Plumbing Piping and Equipment, for piping system isolation.

1.3 QUALITY ASSURANCE

A. Contractor: The fire protection system shall be designed and installed by a fire protection contractor who is licensed by the State of Texas to perform fire protection work of the type specified for this project. The fire protection contractor shall have a minimum of 5 years of experience in the installation of fire protection work of the type specified for this project.
B. 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 basic designation only. The latest editions shall apply.

C. National Fire Protection Association (NFPA):
   2. NFPA 14 Standpipe and Hose Systems.
   5. NFPA 70 National Electrical Code.


E. American National Standards Institute (ANSI):

F. 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.

G. Materials shall be installed in accordance with NFPA 13 and NFPA 14. All valves, fittings, hose, and equipment shall be UL Listed. All necessary points of campus connections shall be matched to campus equipment, unless otherwise noted.

H. All hose threads and coupling types shall conform to local fire department requirements.

I. 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.

J. Fire Protection Specialties:
   1. Potter-Roemer, Inc.
   2. Elkhart Brass Co.

K. Fire Protection Valves:
   1. Grinnell (Tyco).
   3. Milwaukee
   5. Mueller.
1.4 SUBMITTALS

A. Shop drawing submittals shall include, but not be limited to, the following:

1. Cut sheets marked to clearly indicate all fire protection system materials, accessories and manufacturers to be used, including, but not limited to control panels, pipe and fittings, pipe hangers and supports, valves, sprinkler heads, specialties, water flow switches, valve supervisory switches, and other required materials.

2. Final fire protection system fabrication/shop drawings showing all piping sizes and elevations, sprinkler heads and hydraulic calculations. Piping shall be sized and elevation of mains shall be indicated. Drawings and hydraulic calculations shall be submitted and approved by state and local authorities in writing prior to being submitted to the engineer for review. Submit final approved Drawings to UNT and A/E.

3. Other items as required by Sections 22 0500, 21 1300 and 21 1313.

4. All submittals shall bear RME seal and signed.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver fire protection components in factory-fabricated water-resistant wrapping.

B. Handle fire protection components carefully to avoid damage to components, enclosures, and finish.

C. Store fire protection components in a clean, dry space and protect from weather.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Pipe: Aboveground and inside building (downstream from double check valve) provide minimum schedule 40 steel pipe conforming to ASTM A53. Comply with applicable governing regulations and industry standards. For underground pipe and fittings, and pipe and fittings upstream of double check valve, refer to specification section 21 1100.

B. Piping shall be domestically manufactured by one of the manufacturers listed in the latest edition of the American Petroleum Institute (API) approved manufacturers listing.

C. Fittings: Class 150 threaded malleable iron, ANSI B16.3 compliant, for sizes up through 2-inch. Grooved mechanical type coupling for sizes over 2-inch. Welded joints where flanges occur, only allowed on wet pipe systems. All threaded pipe shall be schedule 40 steel, as specified.

D. Malleable Iron Threaded Unions: ANSI B16.3, 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.


F. Steel Flanges/Fittings: ANSI B16.5, including bolting, gasketing, and butt weld end connections. Fittings same thickness as pipe.
G. Forged Steel Socket-welding and Threaded Fittings: ANSI B16.11, rated to match schedule of connected pipe.

H. Wrought Steel Butt-welding Fittings: ANSI B16.9, except ANSI B16.28 for short radius elbows and returns; rated to match connected pipe.

I. Flanged Fittings: Comply with ANSI B16.5 for bolt-hole dimensioning, materials, and flange thickness.

J. 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.

K. Flange Bolt Thread Lubricant: Lubricant shall be an ant-seize compound designed for temperatures up to 1000°F and shall be Crane Anti-Seize Thread Compound or approved equal.

L. Miscellaneous Piping Materials/Products:
   3. Gaskets for Flanged Joints: 1/16 inch thick for till pipe size 10 inch and smaller and 1/8 inch thick for all pipe size 12 inch and larger. Ping-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 nonasbestos 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.

M. Mechanical couplings may only be used for pipe sizes over 2 inches, to engage and lock grooved or pipe ends and to allow for some angular deflection, contraction and expansion. Couplings shall be positive lock type and shall consist of ASTM A536 ductile iron housing, c-shaped composition sealing gasket and carbon steel bolts conforming to ASTM A183. Gasket Material for wet systems shall be EPDM. Gasket material for dry pipe systems shall be silicone. All couplings shall be UL listed. Provide only full flow (no-fabricated) fittings. Snap joint couplings, outlet couplings, cut-in style couplings, reducing couplings, mechanical-T style couplings, pressfit couplings, and plain end type couplings are not allowed. When mechanical couplings are used, ONLY grooved type fittings and pipe shall be used, no plain end fittings or pipe. Grooved couplings and fittings shall be manufactured by Victualic, "Firelock" or approved equal by Gruvlok or Nibco. Couplings shall be manufactured by Victualic "Firelock" Style 005, or approved equal. Where mechanical coupling type piping system is installed, the fittings and couplings shall be of the same manufacturer.

2.2 PIPING FABRICATION/SHOP DRAWINGS

A. Piping fabrication/shop drawings shall be submitted for all fire protection and sprinkler piping.

B. Pipe fabrication/shop drawings shall be to minimum scale on 1/8 inch scale building floor plans and shall indicate pipe size, fittings, valves, accessories, connections, head type, insulation, support requirements, pipe elevations and other information required for coordination with other trades and fabrication of piping.
C. Pipe fabrication/shop drawings shall be coordinated with other trades and building construction prior to submittal to the Engineer for review.

2.3 PIPE HANGERS AND SUPPORTS

A. Pipe Hangers and Supports: Support fire protection pipe with UL-listed and approved hangers and support devices. Provide any special hangers or supports that may be required. The design, selection, spacing, and application of horizontal and vertical pipe hangers, supports, restraints, anchors, and guides shall be a minimum in accordance with the NFPA 13 and NFPA 14, however, all pipe hangers, rods, supports, inserts and other components shall be in accordance with specifications Section 22 0529. All anchors shall be drilled, no shot type anchors are allowed. Refer to Section 22 0529, Hangers and Supports for Plumbing Piping and Equipment, for pipe supports, hangers. Hanger spacing shall be according to NFPA 13 & 14.

2.4 SLEEVES AND ESCUTCHEONS

A. Pipe passing through walls, floors, and partitions shall be provided with standard weight steel pipe sleeves. Sleeves through walls in finished spaces shall be flush. Where located in the floor construction, the sleeves shall project not less than 2 inches above the floor line. Refer to Sections 22 0500 & 22 0529 for fire stopping and additional sleeve requirements. Refer to drawings for details.

B. Provide escutcheons for pipes passing through walls, partitions, or ceilings. Escutcheons shall be provided where pendant sprinkler heads penetrate ceilings or sidewall heads penetrate walls. Pipe escutcheons shall be chrome-plated steel. Sprinkler escutcheons shall be white-painted or chrome-plated steel as specified. Refer to Sections 22 0500 & 22 0526 for additional requirements.

2.5 VALVES AND ACCESSORIES

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

B. Chain Operators: Chain operators shall be provided for all valves installed over 8 inches above finished floor in the central plant, fan rooms, mechanical rooms and other areas where valves are exposed.

C. Flanges: For sizes over 2 inch flanged or grooved end valves shall be used, unless otherwise required by these specifics and NFPA. Valve flanges and companion flanges for all valve applications shall be compatible with the valve rating and the system pressure at the point of application. Flanges shall conform to ANSI B16.1 and ANSI B16.10.

2.6 GENERAL REQUIREMENTS

A. All valves shall be of threaded or flanged type. No solder connected valves on water lines shall be used on this project. Grooved end valves shall only be allowed in the sprinkler system, not the standpipe system. All bronze and iron body gate and globe valves shall be of one manufacture for each project. Manufacturers of other types may not be mixed on the same project; i.e., all butterfly valves shall be of the same manufacture, all ball valves shall be of the same manufacture, etc.
B. All valves at system points where the System Working Pressure (SWP) at the point of application, including appropriate pump shutoff head shall be rated for a minimum 175 psi water working pressure, unless the system pressure exceeds 175 psi, where system components shall have a higher pressure rating.

C. All bronze gate valves for pressures up to 150 psi shall be ASTM B62 composition bronze. Bronze valves for pressures above 150 psi shall be ASTM B61 steam bronze. All bronze valves shall be union or screw over bonnet, rising stem type with ASTM 584 alloy 876 or equal stem material.

D. All bronze ball valves for pressures up to 300 psi shall be ASTM B62 composition bronze.

E. All iron body valves shall have the pressure containing parts constructed of ASTM A 126 Class B cast iron. Stem material shall meet ASTM Alloy 876 or ASTM 371 Alloy 876 silicon bronze or its equivalent. Gates and globes shall be bolted bonnet with OS&Y (outside screw and yoke) and rising stem design. A lubrication fitting shall be provided on yoke cap for maintenance lubrication of the yoke bushing.

F. All valves shall be repackable, under pressure, with the valve in the full open position.

G. All gate valves, globe valves, angle valves and shutoff valves of every character shall have malleable iron hand wheels, except iron body valves 2-1/2 inches and larger which may have either malleable iron or ASTM A 126 Class B, gray iron hand wheels.

H. Packing for all valves shall be selected for the pressure-temperature service of the valve. It is incumbent upon the manufacturer to select the best quality, standard packing for the intended valve service. At the end of one year period spot checks will be made, and should the packing show signs of hardening or causing stem corrosion then all valves supplied by the manufacturer shall be repacked at no expense to the Owner with a packing material selected by the Owner.

I. Valves located with stem in horizontal position shall be drilled and tapped in accordance with MSS-SP-45 at Boss G to accommodate a drain valve.

J. All fire protection valves shall be UL-listed for fire protection use.

K. Where system pressure exceeds 175 psi, the valves shall be rated for a working pressure of a minimum of 200 psi.

2.7 VALVES

A. Gate Valves:

1. Gate valves 2 inches and smaller, where system pressure is 175 psi or less, gate valve shall be 175 WOG rated, UL listed, all bronze outside screw and yoke, rising stem valves with solid wedges and threaded connections, manufactured by Nibco No. T-104-O, or approved equal.

2. Valves 2-1/2 inches and larger, gate valve shall be flanged, UL listed, cast iron body (ASTM A-126), outside screw and yoke, rising stem gate valves with bolted bonnets and solid wedges. Valves shall be rated for 200 psi non-shock rating, manufactured by Nibco No. F-607-RW, or approved equal.
B. Ball Valves:

1. Ball valves, for sizes 2-inch and less, shall be two piece with a standard size port 316 stainless steel balls and stems, and reinforced seats and stuffing box rings. All ball valves shall be designed to permit repacking while valve is in line. Valves shall be furnished with blowout-proof stems.

2. Ball valves shall be threaded ductile iron body or bronze ASTM B584 alloy 844 of a standard port design with gear operator and position indicator. Valves shall be rated for 300 psi WOG and shall conform to UL listed, with supervisory switch, manufactured by Nibco No.KT-505-4W, or approved equal.

3. Grooved end ball valves may be used in the sprinkler system for zone isolation for pipe sizes over 2 inches. Ductile iron body, UL listed, standard port, TFE seats, stainless steel ball & stem, with supervisory switch, rated for 300 psi, manufactured by Victaulic Series 728, or approved equal.

C. Butterfly Valves:

1. For pipe sizes over 2-inch, all butterfly valves shall be full tapped and threaded lug. Manufacturer certified for bubbletight, dead end shut off from either direction at design working pressure and temperature. Valves shall have enclosed, self-locking wheel-operated worm gear type, waterproof, factory-lubricated operators and position indicators.

2. Butterfly valves shall be 250 psig non-shock with ductile iron lug body, EPDM (EPT) replaceable seat, 316 or 416 stainless steel upper and lower stems (stems shall be positively connected to the valve disc) and EPDM (EPT) stem seals. UL listed, with supervisory switch, manufactured by Nibco No. LD-3510-8, or approved equal. Where grooved ends are used provide Victaulic Series 705, or approved equal.

D. Check Valves:

1. Check valves 2-1/2 inch and smaller shall be UL-listed, horizontal swing, regrinding type, renewable seat, 200lb. wwp, bronze body, threaded ends, manufactured by Nibco No. KT-403-W, or approved equal.

2. Check valves 3 inches and larger shall be UL-listed, flanged class 250 cast iron body (ASTM A-126 Class B), bolted bonnet, horizontal swing, renewable bronze seat and disc, manufactured by Nibco No. F-968-B, or approved equal.

3. Within the sprinkler system (not standpipe system) grooved end check valves may be used for pipe sizes over 2-inch. UL listed and, factory tested for 500 psi, approved for services up to 250 psi, ductile iron body, spring assisted, rubber encapsulated disc, manufactured by Victaulic Series 717, or approved equal.

4. Swing check valves, allow adequate pipe clearance to allow for proper valve operation. Provide Grinnell No. 1686 or equal ball drip where required to allow drainage at check valves.

E. Accessories

1. Double Check Valve Assembly: Watts Series 770-OS & Y RW, epoxy coated ductile iron valve bodies, with OS&Y gate valves with tamper switches, stainless steel internal parts, replaceable bronze seats, with bronze body ball valve test cocks.

2. Test/Drain Valves: Test/drain valves for applications to 300 psi shall be threaded connection test/drain valve assemblies with ductile iron body, bronze valve assembly, acrylic sight glass and aluminum orifice inserts. Orifice size shall coordinate with sprinkler head sizes, installed on the zone served. Test drains to be located within reach of the floor, not to exceed 7'-0".
3. Unions: Provide in lines assembled with screwed and soldered fittings at points of connection to items of equipment and elsewhere as indicated or required to permit proper connections to be made or so that equipment may be removed. Unions shall also be provided in welded lines at the connections to items of equipment, where flanges are not provided.

4. Unions in steel lines assembled with screwed fittings shall be malleable iron screwed pattern unions with bronze seats. Unions in copper or brass lines shall be all brass, threaded pattern unions. Where unions are required by the above in steel lines assembled by welding, they shall consist of two mating welding flanges.

5. Dielectric unions shall be used at all junctures of dissimilar metals.

6. Unions in 2 inch and smaller in ferrous lines shall be Class 300 AAR malleable iron unions with iron to brass seats, and 2-1/2 inch and larger shall be ground flange unions. Companion flanges on lines at various items of equipment, machines and pieces of apparatus shall serve as unions to permit removal of the particular items. See particular Specifications for special fittings and pressure.

7. Flanges: All flanges shall be weld neck and shall be domestically manufactured, forged carbon steel, conforming to ANSI B16.5 and ASTM A 181 Grade 1 or Grade 2 or A-1 05-71 as made by Tube Turn, Hackney or Ladish Company. Slip on flanges will not be acceptable. Each fitting shall be stamped as specified by ANSI B16.9 and, in addition, shall have the laboratory control number stenciled on each fitting for ready reference as to physical properties and chemical composition of the material. Complete test reports may be required for any fitting selected at random. Flanges which have been machined, remarked, painted or otherwise produced domestically from imported forgings or materials will not be acceptable. The flanges shall have the manufacturer's trademark permanently identified in accordance with MSS SP-25. Submit data for firm certifying compliance with these Specifications. Gaskets used shall be ring form, dimensioned to fit accurately within the bolt circle, shall be 1/16 inch thick, Manville service sheet packing Style 60. Inside diameter shall conform to the nominal pipe size. Bolts used shall be carbon steel bolts with semi-finished hexagon nuts of American Standard Heavy dimensions. All-thread rods will not be an acceptable for flange bolts. Bolts shall have a tensile strength of 60,000 psi and an elastic limit of 30,000 psi. Flat faced flanges shall be furnished where required to match flanges on pumps, check valves, strainers, and similar items. Only one manufacturer of weld flanges will be approved for each project.

8. Gaskets: Gaskets shall be placed between the flanges of all flange joints. Such gaskets shall be ring form gaskets fitting within the bolt circle of their respective flanges. Gaskets shall be 1/16" thick Manville Service Sheet Packing Style 60. The inside diameter of such gaskets shall conform to the nominal pipe size and the outside diameter shall be such that the gasket extends outward to the studs or bolts employed in the flanged joint.

9. Flexible Connections: Refer to the Plumbing Section for flexible connections.

2.8 FIRE PROTECTION SPECIALTIES

A. Water Flow Switches: Viking Model C-1 or approved equal water flow switch with adjustable retard feature. Switch shall be two single pole double-throw type or one double pole double throw and shall be rated at least 7 amperes at 125/250 volts.

B. Valve Supervisory Switches: Provide on each valve, controlling or shutting-off sprinkler system where shown on drawings or/and on all valves required by NFPA 13 & 14, or any portion thereof. Provide UL listed unit, with two single pole double throw switches or one double throw double pole switch. Switch shall be compatible with installed valve for standard mounting. Manufactured by Potter Roemer No. 6220, or approved equal.

C. Sight Flow Connection: Provide acrylic sight flow connection in all test lines, conforming to NFPA 13.
D. Pressure Gauges: Potter-Roemer Fig. No. 6240 or approved equal 3-1/2 inch diameter polished brass case, 1/4 inch NPT male connection, glass enclosed, 0-300 psi dial pressure gauges with isolation valves.

PART 3 - PRODUCTS

3.1 INSTALLATION OF FIRE PROTECTION PIPING SYSTEMS

A. General: All piping system materials, components and installation shall be in accordance with NFPA 13, and NFPA 14, and these specifications.

B. Standpipe, riser and main piping shall be Schedule 40 black steel pipe.

C. Sprinkler system piping shall in general be as specified herein above for fire standpipe piping. The use of thin wall sprinkler piping will not be acceptable.

D. Fittings 2 inch and smaller for Schedule 40 pipe shall be Class 150 malleable iron threaded fittings.

E. Fittings for piping 2-1/2 inch and larger shall be UL Listed grooved type fittings and/or flanges. Where flanges are used, the flanges shall be weld neck type.

F. Install fire department valves within stairwells at 42 inches above finished floor.

G. All piping and joints shall be full bore reamed, for all joint types.

H. All welded joints shall have the slag removed and all welded couplings shall be full bore and all slag removed.

3.2 PIPING INSTALLATION

A. Piping shall be concealed, except in mechanical equipment rooms, stairwells, or where otherwise indicated on the Drawings. Install all piping parallel to or at right angles to the column lines of the building wherever possible.

B. Grade piping to eliminate traps and pockets and for drainage per NFPA 13 and NFPA 14. Where air pockets or water traps cannot be avoided, provide hose bibbs for drainage.

C. Sprinkler protection is required in electrical rooms unless otherwise indicated. It shall be the responsibility of the Fire Protection Contractor to coordinate electrical equipment locations with the Electrical Contractor and design the fire protection piping system such that no piping is routed over electrical equipment.

D. All changes in direction, branches, offsets etc., shall be made with standard pipe fittings. Holes in the main for branches shall be made with a hole cutting machine and a standard "Weld-O-Let' or 'Thread-O-Let' fitting used. Burning holes in the fire protection System Piping will cause that section of the piping to be cut out and replaced at the Contractor's expense. Galvanized piping systems shall not have welded components such as welded outlets, welded flanges, butt welds, etc. Entire interior of the galvanized piping system shall have the undisturbed factory galvanized finish throughout at completion of system, field application of galvanizing on interior of pipe is not allowed except where rolled grooved joints occur.
E. All pipe shall be reamed to full pipe diameter before joining. Screwed joints shall be made with standard pipe thread and an approved compound applied to the male thread only. Welded joints at flanges shall be made in accordance with the procedure outlined in the ANSI piping code. Valves and specialties shall be screwed or flanged joints. Grooved joints shall be made in accordance with manufacturers recommendations with UL listed couplings or weld-o-let connections to pipe mains shall be full bore. Slag, etc. shall be removed.

F. Install unions or flanges at equipment connections and as indicated on the drawings.

G. Cold-springing piping will not be permitted. Install piping with adequate support to prevent strain on the equipment and to allow for piping system expansion and contraction.

H. Welded joints at flanges shall be made with continuous welds and with pipe ends beveled before fabrication. Piping shall be carefully aligned prior to welding and no metal shall project within the pipe.

I. Piping shall be sized as required by applicable codes and as indicated on the Drawings.

J. Provide all test and drain lines as required by Sections 8.16.2 NFPA 13. Pressure gauges, signs, and other such standard appurtenances shall be furnished as required for a complete installation in accordance with NFPA 13. A nameplate data sign shall be provided at the zone controlling valve to identify the system as a hydraulically designed system indicating the location and basis for design in accordance with Chapter 6 of NFPA 13.

K. All sprinkler piping shall be so installed that it can be thoroughly drained, and where practicable shall be arranged to drain at the zone drain valve. The zone drain valve shall be capable of a full discharge test without allowing water to flow onto the floor. All drips and drains shall conform to 8.16.2 of NFPA No. 13.

L. Field changes in the piping layout or pipe sizes shall not be made without the prior approval of the Engineer.

3.3 PIPE HANGERS AND SUPPORTS

A. Pipe supports, sway braces, hangers, and clamps shall conform to and be placed in accordance with Chapter 9 of NFPA 13 and listed by Underwriters' Laboratories, Inc.

B. All pipe shall be supported from the building structure in a neat and workmanlike manner and wherever possible, parallel runs of horizontal piping shall be grouped together on trapeze type hangers. Vertical risers shall be supported at each floor line with steel pipe clamps. The use of wire or perforated metal to support pipes will not be permitted. Hanging pipes from other pipes will not be permitted. Spacing of pipe supports shall not exceed 10 feet on all piping. "Shots" or any power driven hanger supports will not be acceptable.

C. All standpipe and sprinkler piping shall be adequately supported to avoid excess strain on fittings and joints. As a minimum, all vertical risers shall be supported at the bottom level, the top level and at each alternate level in between.

D. Where pendant sprinklers are used, care shall be taken to resist upward movement of flowing sprinklers by means of rigid hangers or other restraints on the ends of branch lines or arm over exceeding 5 feet in length.
E. 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. All valves shall be located so as to make the removal of their bonnets possible. All flanged valves shown in the horizontal lines with the valve stem in a horizontal position shall be positioned so that the valve stem is inclined one bolt hole above the horizontal position. Screw pattern valves placed in horizontal lines shall be made up with their valve stems inclined at an angle of 30 degrees above the horizontal position. All valves must be true and straight at the time the system is tested for final acceptance. Valves shall be installed as nearly as possible in the locations as shown on and Drawings. Any change in valve location must be so indicated on the As-built Drawings.

F. Valve Chain Operators: In mechanical rooms where valves are installed over 8 feet above floor, provide chain operators.

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

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

I. Access Doors and Panels: Provide access doors or panels as required to provide full valve access. Refer to Section 22 0500 for additional requirements.

J. Strainer Blowdown: Provide a blowdown valve with hose connection and cap at each strainer for blowdown.

K. Gauges: Provide gauges as required by NFPA 13 and NFPA 14 and as follows:

1. On the suction side of each fire and jockey pump.
2. On the discharge side of each fire and jockey pump.
3. At the fire service water entry.
4. At the top of each standpipe and sprinkler riser.
5. Where shown on the Drawings.

3.4 PROTECTION DURING CONSTRUCTION

A. Provide necessary fire protection during construction in accordance with NFPA and local codes.

3.5 CLEANING AND STERILIZATION

A. All fire protection piping shall be thoroughly flushed out, to remove any slag or debris prior to being tested or put into service. Comply with NFPA standards and guidelines. Underground piping extending from the water supply to the system riser and lead-in connections to the system riser shall be completely flushed before connection is made to downstream fire protection system piping. The flushing operation shall be continued for a sufficient time, as determined by Owner or Architect/Engineer to ensure thorough cleaning. The minimum rate of flow shall not be less than a flow necessary to provide a velocity of 10 feet per second in accordance with in NFPA 13 or hydraulically calculated water demand rate of the system, including fire hose requirements. Provisions shall be provided for proper disposal of water used for tested and flushing. Refer to NFPA 13 Section 8.16.3, Section 10.10.2.1 and Section A.10.10.2.1 for methods of flushing water supply connections. Owner shall be provided in writing the flushing procedure and shall witness and approve flushing of system prior to continuation of work. Flush piping system without sprinkler heads installed. Contractor is responsible for providing any pump required for flushing system at the specified velocity. Flush
piping system at the ends of the cross mains. Individual sprinkler heads shall not be installed during flushing. The individual supply lines to each sprinkler head shall be capped during the flushing procedure. After the piping system has been flushed. The individual capped lines shall be drained and any debris, slag, etc. removed. The sprinkler heads shall then be installed once the system has been approved as successfully cleaned and flushed.

3.6 VALVE SUPERVISORY SWITCHES

A. All valves that affect the flow of fire protection water to any area shall be supervised. Supervisory switches shall be furnished and installed by this Contractor and wired by Division 26. Coordinate wiring of all switches with Division 26.

3.7 WATERFLOW PRESSURE SWITCHES

A. Waterflow pressure switches shall be furnished and installed by this Contractor in locations required by NFPA and where shown on the Drawings. Switches shall be wired by Division 26. Coordinate wiring of flow switches with Division 26.

3.8 BUILDING FIRE ALARM SYSTEM INTERFACE

A. Each device, such as supervision switches, fire pump operation, flow switches, etc. shall provide an alarm signal output to the Building Fire Alarm System (wiring by Division 26).

B. Each valve which controls the flow of sprinkler system water shall be monitored by the Building Fire Alarm System, unless otherwise noted.

3.9 ALARM CHECK VALVE AND WATER MOTOR GONG

A. Refer to Section 21 1313.

3.10 TESTS AND INSPECTIONS

A. Inspections, examinations and tests required by the authorities or agencies specified shall be arranged and paid for by the Fire Protection Subcontractor, 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 Engineer for review and distribution.

B. Fire protection piping systems shall be hydrostatically tested by the Contractor upon completion of the installation as required by NFPA 14 and NFPA 13 in the presence of the Owners Representative. When hydrostatic and alarm tests have been completed and all necessary corrections made, a material and test certification shall be provided in accordance with Chapter 25 of NFPA 13. Final inspection shall include full flow testing through the inspector's test connection. Actuation of the flow switch shall occur within one minute of opening of the inspector's test valve. The final tests may be witnessed by the Engineer or Owner's Representative.
The fire protection standpipe system shall be tested as required by the Owner and as follows. The standpipes shall be tested with 500 gpm flowing from one standpipe top floor Fire Department outlet and 250 gpm flowing from each other standpipe top floor Fire Department connection. A residual pressure of 100 psi at the 500 gpm at the most remote outlet shall be provided. These tests shall be conducted with calibrated nozzles, flow pilots and calibrated pressure gauges.

Sprinkler system zone control assemblies shall be tested to demonstrate proper operation of the flow switch and valve supervisory switch.

Arrange and pay for all tests and inspections required by authorities having jurisdiction.

After completion of the fire protection system installation and at the beginning of the guarantee period, the Automatic Sprinkler Subcontractor shall execute the National Automatic Sprinkler and Fire Control Association, Inc., Standard Form of "Inspection Agreement", without change in the Contract amount, calling for four inspections of the fire protection system during the warranty period. During the warranty period, inspections shall be in accordance with the Inspection Agreement, plus the following maintenance to be performed during the course of the fourth inspection:

1. Operation of all control valves.
2. Lubrication of operating stems of all interior valves.
3. Operation of all alarms, supervisory switches, air compressors, alarm trip switches, flow switches, and similar items.
5. Lubrication of Fire Department valve hose connections.

Refer to Section 21 0553 for applicable nameplates, labeling requirements and Section 09 900 for Painting.

Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner's Representative. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the Owner's Representative after submission and approval of formal training plans. Refer to Section 01 9113, General Commissioning, for contractor training requirements.
3.14 FUNCTIONAL PERFORMANCE TESTING

A. Functional Performance Testing is part of the Commissioning Process. Functional performance testing shall be performed by the Contractor and witnessed and documented by the Commissioning Agent. Refer to Section 01 9113, General Commissioning, for functional performance testing and commissioning requirements.

END OF SECTION
SECTION 21 1313

FIRE PROTECTION SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes labor and materials for the renovation of a hydraulically calculated automatic, wet-pipe sprinkler system and as shown on the Drawings, complete in all respects and ready for operation.

1. Work includes the design of an automatic sprinkler system, complete and ready for operation.
2. Design and installation of the sprinkler system shall be such that no parts interfere with general construction, doors, windows, heating, plumbing, air conditioning systems or electrical equipment.

B. System components for each zone shall include, but not be limited to:

1. Zone control valve and test/drain assembly.
2. Drain valve.
3. Waterflow switches.
4. Valve supervisory switches.
5. Piping.

1.2 SYSTEM DESCRIPTION

A. The automatic sprinkler system shall be fixed water type or pre-action type fire protection sprinkler system (where indicated on floor plans) with piping supply to fusible sprinkler heads for control of fire.

B. The sprinkler system shall be designed to meet the more stringent of the requirements of NFPA 13.

C. All sprinkler heads in general shall be in a straight line, parallel to the lines of the building and shall be located in the approximate center of ceiling tiles.

1. Sprinkler head quantities, where shown, are the minimum, which must be provided. If additional heads are required to meet NFPA 13, the location of additional heads must be approved by the Architect.
2. Contractor shall submit Sprinkler Head locations to the Architect for location and type approval prior to completing the sprinkler system design, unless otherwise instructed, in writing, by the Architect.

D. Work shall be installed in accordance with the Drawings, Specifications. Devices and equipment shall be listed by Underwriters' Laboratories, Inc. individually and as a system, as applicable.
E. Sprinkler heads shall be spaced, located, and positioned as shown on the Architectural reflected ceiling plans, where shown, as specified and as required to suit the building partition layout according to Sections 8.5 and Section 8.6 of NFPA 13.

F. Piping sizes and configurations shall be on the basis of hydraulic calculations. Where head layouts shown on the Drawings or requirements specified are more stringent than NFPA requirements, the more stringent requirements shall apply.

G. Zone the wet-pipe sprinkler system with a maximum 52,000 sq. ft. area limitation per zone.

H. Coordinate the location of sprinkler heads and piping such that it does not interfere with the installed ceiling configuration or other building construction and equipment.

1.3 HYDRAULIC CALCULATIONS

A. Prepare hydraulic calculations in accordance with NFPA 13 with the following exceptions:

1. Pipe frictions losses may be calculated by using the nearest foot for all piping over one foot in length. Vertical length less than one foot shall be included for elevation purposes only.
2. Calculate flows to the nearest whole gallon.
3. Total sprinkler system flow shall not exceed 110 percent of the required flow.
4. Provide a minimum safety factor of 10 percent on all hydraulically calculated sprinkler systems.
5. Base calculations on certified flow test information. This contractor is responsible for current flow test information.

B. Sprinkler system hydraulic calculations shall be based on the following:

1. Offices, Conference Rooms, Entries, Hallways, Multipurpose Rooms, Non-Lab related Classrooms, Assembly Areas, Locker Rooms, Lecture Rooms, Corridors, Common Areas and Similar Areas: Light Hazard Occupancy with design density of 0.10 gpm over the most remote 1500 square foot, with a maximum coverage area, per head, of 225 square foot.
2. Storage Rooms, Mechanical Rooms, Communication Rooms, Control Rooms, Secondary Electrical Rooms, Data Rooms, Loading Dock, Chemical Storage Rooms, Laboratories type spaces, and Janitor Rooms: Ordinary Hazard Group 2 with a design density of 0.20 gpm over the most remote 1,500 square foot with a maximum with a maximum head coverage of 130 square foot.
5. Main Electrical Room and Main Emergency Electrical Room are not to have sprinkler protection (rooms are 2 hour rated).

C. Hydraulic calculations shall be performed by a State of Texas Licensed Responsible Managing Employee (RME) in the direct employ of the fire protection contractor.

D. Hydraulic Calculations shall be based on flow test conducted by this contractor or flow test information provided by the Owner. This Contractor is responsible for basing the hydraulic calculations on the most current conditions.
1.4 SUBMITTALS

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

B. Shop Drawings: Provide total hydraulically designed sprinkler system with plans, elevations, sections, details, and related attachments including Wiring Diagrams for power, signal, and control wiring.

C. All submittals shall be provided to A/E for review and approval prior to any work.

D. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

E. Qualification Data: For qualified Installer and Professional Engineer.

F. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

G. Welding certificates.

H. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."

I. Field quality-control reports.

J. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
      a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the latest edition of the following:
   1. NFPA 13, "Installation of Sprinkler Systems."
   2. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."
PART 2 - PRODUCTS

2.1 SPRINKLERS

A. Approved Manufacturers: Viking, Victaulic, Tyco or Reliable.

B. Unless otherwise specified, sprinkler heads shall be a quick response type with standard (155°F) temperature rated fusible link, 1/2 inch orifice and a 5.6 K factor.

1. Heads located within the air streams of heat emitting equipment and serving Elevator Machine Rooms, Elevator Shafts and Boiler Rooms shall have an intermediate (200°F) temperature rated fusible link.
2. Install corrosion-resistant sprinkler heads where they are exposed to weather, moisture, or corrosive vapors.
3. Heads installed where they might receive mechanical injury or are less than 7 feet above the floor level shall be protected with approved guards in accordance with Section 6.2.8 of NFPA 13.
4. Sprinklers in areas with suspended ceilings shall have pipe and fittings located above the suspended ceiling.
5. Sprinkler heads shall be located above and below metal mesh ceiling. Refer to architectural RCP for location of metal mesh ceilings.
6. Sprinkler heads in finished areas, with ceilings, shall be Standard Response concealed type sprinkler head, manufactured by Victaulic Model V38 or approved equivalent. All concealed heads shall have white finish, except in wood ceilings where a factory painted custom dark brown finish shall be provided.

C. Sprinkler heads in unfinished areas shall be Quick Response upright or sidewall with a brass finish, manufactured by Viking Microfast Model VK300 or approved equivalent.

1. Where sprinkler heads are required for electrical and IDF rooms, the heads shall be sidewall and not located directly above any equipment.

D. Sprinkler heads for the 2-Hr fire rating of glazing shall be Tyco WS 5.6 k-factor window pendant sprinkler heads. Refer to plumbing drawings for required locations. Refer to manufacturer’s installation guideline for placement of sprinkler heads.

E. Provide concealed type dry type sprinkler head with white finish and escutcheon, to protect freezers, manufactured by Victaulic Model V36 dry pendant or approved equal.

F. Provide recessed horizontal dry sidewall pendant sprinklers to protect outside areas as indicated on the plumbing plans, such as Loading Docks and Outdoor Service Area, manufactured by Victaulic Model V3609 Dry Horizontal Sidewall pendant or approved equal.

G. Sprinkler heads shall be UL Listed.

H. Provide semi-recessed dry pendant type heads in Freezer Rooms and in other rooms where the temperature will be below 40 degrees F.

I. Provide metal cabinet containing a stock of spare sprinkler heads of all types and ratings installed.

1. Locate cabinet where temperature will not exceed 100°F.
2. Location shall be approved by the Owner.
3. Number of spare sprinklers shall conform to Section 16.2.7 of NFPA 13.

4. Provide a sprinkler wrench in the cabinet, for each different type sprinkler head.

J. The use of extended coverage type heads is not allowed.

K. The use of UL listed flexible type head assemblies is permitted. Flex type head assembly shall consist of 304 stainless steel braided hose with zinc plated steel 1" NPT male threaded nipple, factory tested at 400 psi, complete with one piece head securing bracket assembly, tamper resistant screws, The drop shall include a UL approved Series AH2 braided hose with a bend radius to 2" to allow for proper installation in confined spaces. The hose shall be listed for [(4) bends at 31” length] [(5) bends at 36” length] [(8) bends at 48” length] [(10) bends at 60” length] [(12) bends at 72” length]. Manufactured by Victaulic “Aquaflex”.

2.2 VALVE SUPERVISORY SWITCHES

A. Contractor shall furnish and install supervisory switches. Coordinate wiring of switches with Division 26 Electrical Sections.

2.3 WATERFLOW SWITCHES

A. Waterflow pressure switches shall be furnished and installed by this Contractor and wired under provisions of Division 26 Electrical Sections. Coordinate wiring of flow switches with Division 26 Electrical Sections.

2.4 BUILDING FIRE ALARM SYSTEM INTERFACE

A. Each zone control assembly shall provide an alarm signal output to the Building Fire Alarm System whenever there is waterflow in the zone. Coordinate with Division 28 Electronic Safety and Security Sections.

B. Each valve which controls the flow of sprinkler system water shall be monitored by the Building Fire Alarm System. Coordinate with Division 28 Electronic Safety and Security Sections.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.

C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
D. Install unions adjacent to each valve in pipes NPS 2 and smaller.

E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

G. Install sprinkler piping with drains for complete system drainage.

H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

I. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.

J. Install alarm devices in piping systems.

K. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

L. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

M. Fill sprinkler wet system piping with water.

N. In rooms with servers do not locate sprinkler heads directly over servers.

O. In areas with wood ceilings, provide sprinkler heads in the ceiling and above the ceiling in compliance with NFPA 13.

3.2 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system’s pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.

I. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to “Quality Assurance” Article.

1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

J. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

K. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

L. Steel-Piping, Pressure-Sealed Joints: Join Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

M. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

N. No welded joints and/or outlets are allowed on the pre-action piping system.

3.3 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Specialty Valves:

1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.

3.4 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.
B. Install automatic (ball drip) drain valve at each check valve for fire-department connection.

C. Coordinate the location of sprinkler system piping around all other trades, such as HVAC, plumbing and electrical, prior to installation.

D. Provide sprinkler protection for the electrical equipment rooms, except the Main Electrical Room and the Emergency Electrical Room, located on level 1, where sprinkler protection is not to be provided. Refer to plumbing floor plans for locations.

E. Do not route any sprinkler system components through electrical equipment rooms, unless they serve that room.

F. The supply line for individual sprinkler heads located in suspended ceilings shall be tapped off the top of the branch lines (return bend). Piping serving individual sprinkler heads located in suspended ceilings shall not be supplied off the bottom of branch lines. Refer to plumbing drawings for detail.

G. In exposed areas with ductwork 48” and wider, provide sprinkler heads both above and below ductwork as outlined in NFPA 13.

H. Provide sprinkler heads both above and in ceilings constructed of wood, as required by NFPA 13.

I. For installation of flex head assemblies follow flex sprinkler assembly manufacturer recommendations. Flex head assemblies shall not connect to cross mains from the bottom of the pipe, only from the side or top.

3.5 ESCUTCHEON INSTALLATION

A. Install escutcheons for penetrations of walls, ceilings, and floors.

3.6 SLEEVE INSTALLATION

A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.

B. Sleeves are not required for core-drilled holes.

C. Permanent sleeves are not required for holes formed by removable PE sleeves.

D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.

E. Install sleeves in new partitions, slabs, and walls as they are built.

F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section, Joint Sealants.

G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section, Joint Sealants.
H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals.

I. Seal space outside of sleeves in concrete slabs and walls with grout.

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

3.7 SLEEVE SEAL INSTALLATION

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

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

3.8 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 0553, Electrical Identification.

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.

   a. Concealed sprinkler caps are not to be installed until after the AHJ has visually inspected sprinklers with suspended ceiling and sprinklers in place.

4. Energize circuits to electrical equipment and devices.

5. Start and run excess-pressure pumps.

6. Coordinate with fire-alarm tests. Operate as required.

7. Coordinate with fire-pump tests. Operate as required.

8. Verify that equipment hose threads are same as local fire-department equipment.

C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.
3.10 CLEANING

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers with paint other than factory finish.

END OF SECTION
SECTION 22 0500
COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the common work results requirements for Division 22, Plumbing. Applicable provisions of this Section apply to all Sections of Division 22.

1.2 GENERAL

A. Contract drawings are diagrammatic only and do not give fully dimensioned locations of various elements of work. Determine exact locations from field measurements and provide coordination drawings.

B. Prior to starting work, Contractor shall provide 1/4 inch scale coordination drawings for all areas of the buildings for approval by Architect/Engineer.

1. Drawings shall show all equipment, ductwork, cable trays, fire protection systems, coil pull spaces, chilled water, heating water, and condensate piping and trap, electrical conduit, electrical control panels, etc. installed to verify space allocation and coordination of trades.

2. Provide plan and elevation views detailing installation.

3. Do not proceed with construction of plumbing systems until Drawings have been approved by Architect, Engineer, and Owner.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than plumbing and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and plumbing equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
1.4 CODE REQUIREMENTS AND PERMITS

A. Perform work in accordance with applicable statutes, ordinances, codes, and regulations of governmental authorities having jurisdiction.

B. Resolve code violations discovered in contract documents with Engineer prior to award of Contract. After award of Contract, make correction or addition necessary for compliance with applicable codes at no additional cost to Owner.

C. Obtain and pay for all permits and inspections.

1.5 SUBMITTALS

A. Material and Equipment List: Within 30 days after award of the contract and before orders are placed or shop drawings are submitted, submit a list of equipment and principal materials specified. Give names of manufacturers, catalog and model numbers, and such other supplementary information as necessary for identification.

B. Material and Equipment Shop Drawings: Submit all detailed shop drawings, descriptive literature, physical data, and performance data at one time for review for items of equipment and for principal materials proposed for installation. Include identifying symbols and equipment numbers used in plans and specifications, with reference to specification paragraphs, and drawing numbers of all equipment and material submitted.

C. Final Submittal: In addition to number of copies of shop drawings and other data required for review submittals, maintain a separate file of final approved copies of such material. Deliver approved copies in a hard-back binder for the Owner's use. Incorporate changes and revisions made throughout construction period. Delivery of approved copies is a condition of final acceptance for the project.

D. Contractor's Check: Shop drawings will be submitted only by the Contractor. Indicate by signed stamp that the drawings have been checked, that the work shown on the drawings is in accordance with contract requirements and that dimensions and relationship with work of other trades have been checked. If drawings are submitted for approval that have not been checked and signed by the Contractor, they will be returned for checking before being considered by the Architect/Engineer.

1.6 OPERATING AND MAINTENANCE INSTRUCTIONS

A. The Contractor shall furnish five copies of commercially available standard operation and maintenance data, including operating instructions, maintenance instructions and parts listings. Detailed requirements for these items are as follows:

1. Information required for the preparation of O&M manuals may be furnished in the form of manufacturers' standard brochures, schematics, and other printed instructions. Clearly distinguish between information which applies to the equipment and information which does not apply. Data shall include as a minimum the following items:
   a. Recommended procedures and frequencies for preventive maintenance, inspection, adjustment, lubrication, cleaning, etc.
   b. Special tools and equipment required for testing and maintenance.
   c. Parts lists reflecting the true manufacturer's name, part number, and nomenclature.
d. Recommended spares by part number and nomenclature and spare stocking levels.

e. Integrated mechanical and electrical system schematics and diagrams to permit operation and troubleshooting after acceptance of the system.

f. Troubleshooting, checkout, repair, and replacement procurement procedures.

g. Operating instructions including start-up and shutdown procedures.

h. Safety considerations including load limits, speed, temperature, and pressure.

B. Provide O&M manuals for all plumbing equipment. Coordinate O&M manuals with Division 01.

C. Upon completion of work, and at time designated by the Architect/Engineer, provide services of a competent representative of the Contractor for a period of at least 40 hours to instruct the Owner's Representative in the operation and maintenance of the entire system.

1.7 PROJECT RECORD DOCUMENTS

A. Preparation:

1. Maintain at the job site a separate set of white prints of the contract drawings for the sole purpose of recording the "as-built" changes and diagrams of those portions of work in which actual construction is significantly at variance with the contract drawings.

2. Mark the drawings with a colored pencil.

3. Prepare, as the work progresses and upon completion of work, drawings clearly indicating locations of various lines, valves, ductwork, traps, equipment, and other pertinent items, as installed.

4. Include flow-line elevation of sewer lines.

5. Record underground and underslab piping installed, dimensioning exact location and elevation of such piping.

6. Coordinate requirements for Project Record Documents with Division 01.

B. Deliver: At conclusion of project, obtain without cost to Owner, reproducibles of original mechanical drawings and transfer as-built changes to these. Delivery of as-built prints and reproducibles is a condition of final acceptance.

C. Provide and post a laminated copy (3 total) of the following record drawings on 11" X 17" paper in the main electrical room, mechanical pump room, and mechanical penthouse.

Z.1. Drawings P10CB, P101A, P101B, P102A, P103A, P104A, P105A, P400, P402 with all Domestic and RO water isolation valves highlighted and tagged. Additionally highlight tag all valves used for draining the domestic and RO water systems. Reference 230010, 3.17, for domestic and RO drain procedures for additional clarification of service valve locations to be highlighted.

1.8 GUARANTEE

A. Guarantee work for 1 year from the date of final acceptance of the project, and during that period make good any faults or imperfections that may arise due to defects or omissions in materials or workmanship. Coordinate requirements for Warranty with Division 01.
1.9 SERVICE

A. Perform service work required during the guarantee period including lubrication of bearings. Perform service monthly, and provide the Owner with a written report. Cleaning of air filters and pipe strainers is not included.

1.10 REFERENCE SPECIFICATIONS AND STANDARDS

A. Materials which are specified by reference to Federal Specifications; ASTM, ASME, ANSI, or AWWA Specifications; Federal Standards; or other standard specifications must comply with latest editions (except where specified otherwise in individual sections), revisions, amendments or supplements in effect on date bids are received.

1. Requirements in reference specifications and standards are minimum for all equipment, material and work.
2. In instances where capacities, size or other feature of equipment, devices or materials exceed these minimums, meet listed or shown capacities.

1.11 CUTTING AND PATCHING

A. General: Cut and patch walls, floors, etc., resulting from work or by failure to provide proper openings or recesses in new construction.

B. Methods of Cutting:

1. Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Architect/Engineer.
2. Impact-type equipment shall not be used except where specifically acceptable to the Architect/Engineer.
3. Openings in precast concrete slabs for pipes, conduits, outlet boxes, etc., shall be core drilled to exact size.

C. Restoration:

1. All openings shall be restored to "as-new" condition under the appropriate Specification Section for the materials involved, and shall match remaining surrounding materials and/or finishes.

D. Masonry:

1. Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry.
2. Adequate supports shall be provided during the cutting operation to prevent any damage to the masonry occasioned by the operation.
3. All structural members, supports, etc., shall be of the proper size and shape, and shall be installed in a manner acceptable to the Architect/Engineer.

E. Special Note: No cutting, boring, or excavating which will weaken the structure shall be undertaken.
1.12 EXCAVATION, TRENCHING AND BACKFILL

A. Excavation: See Divisions 00, 01, and 31 for special requirements related to excavation and trenching.

B. The Mechanical and Electrical subcontractors shall perform all excavations of every description, for their particular installations and of whatever substances encountered, to the depths indicated on the Drawings and/or required for the installation of piping, conduit, utility systems, etc.

C. All exterior lines shall be installed with a minimum cover of 24 inches, unless otherwise indicated.
   1. Generally, more cover shall be provided if grade will permit.
   2. All excavation materials not required for backfill or fill shall be removed and wasted as acceptable to the Construction Inspector.
   3. All excavations shall be made only by open cut. The banks of trenches shall be kept as nearly vertical as possible and where required, shall be properly sheeted and braced.
   4. Trenches shall be not less than 12 inches wider or more than 16 inches wider than the outside edges of the pipe to be laid therein, and shall be excavated true to line so that a clear space not less than 6 inches or more than 8 inches in width is provided on each side of the pipe.
   5. For sewers, the maximum width of trench specified applies to the width at and below the level may be made as wide as necessary for sheeting and bracing, and the proper installation of the work.

D. The bottom of trenches shall be accurately graded to provide proper fall and uniform bearing and support for each section of the pipe on undisturbed soil or 2” of sand fill at every point along its entire length, except for portions of the pipe sections where it is necessary to excavate for bell holes and for the proper sealing of pipe joints.

E. Bell holes shall be dug after the trench bottom has been graded.
   1. Where inverts are not shown, grading shall be determined by the National Plumbing Code for the service intended and the size used.
   2. Bell holes for pipe joints shall be 12 inches in depth below the trench bottom and shall extend from a point 6 inches back of the face of the bell.
   3. Such bell holes shall be of sufficient width to provide ample room for caulking.
   4. Bell holes for sewer tile and water pipe shall be excavated only to an extent sufficient to permit accurate work in the making of the joints and to ensure that the pipe, for a maximum of its length, will rest upon the prepared bottom of the trench.
   5. Depressions for joints other than bell-and-spigot shall be made in accordance with the recommendations of the joint manufacturer for the particular type of joint used.
   6. In general, grading for electrical ductbanks and conduits shall be from building to manhole, and from a high point between manholes to each manhole.
   7. Special pipe beds shall be provided as specified hereinafter.

F. The lower 4” of the pipe trenches measuring from an overhead line set parallel to the grade line of the sewer shall be excavated only a few feet in advance to the pipe laying, by men especially skilled in this type of work.
   1. Where damage is likely to result from withdrawing sheeting, the sheeting shall be left in place.
   2. Except at locations where excavation of rock from the bottom of trenches is required, care shall be taken not to excavate below the depths required.
3. Where rock excavation is required, the rock shall be excavated to a minimum overdepth of 6 inches below the trench depths specified.
4. The overdepth rock excavation and all excess trench excavation shall be backfilled with sand.
5. Whenever wet or otherwise unstable soil incapable of properly supporting the pipe is encountered in the trench bottom, such soil shall be removed to a depth and for the trench lengths required, and then backfilled to trench bottom grade, as hereinafter specified, with sand.

G. All grading in the vicinity of excavation shall be controlled to prevent surface ground water from flowing into the excavations. Refer to appropriate Sections of Division 31.

H. All shoring and sheeting required to perform and protect the excavations and to safeguard employees and/or adjacent structures shall be provided. Refer to appropriate Sections of Division 31.

I. Excavate as required under the building in order that all piping, ductwork, etc., shall clear the ground a minimum of 12 inches for a distance of 24 inches on either side. Edges of such excavations shall slope at an angle of not over 45° with the horizontal unless otherwise approved by the Construction Inspector. The bottom of such excavation shall be graded to drain in a manner acceptable to the Construction Inspector.

J. Trenches for cast iron drain, storm water, and sewer lines inside the building shall be properly excavated, following, in general, the procedures set out for exterior lines. Where floors are to be poured over these lines, they shall be backfilled, tamped, and settled with water. Where no flooring is to cover the lines, they shall be backfilled to form a level grade.

K. All surplus materials removed in these trenching operations becomes the property of the contractor, and shall be disposed of at the expense of the contractor, at a legal disposal site.

L. Backfilling:
   1. Trenches shall not be backfilled until all required tests are performed and until the piping, utilities systems, etc., as installed are certified by the Owner's inspector to conform to the requirements specified hereinafter. The trenches shall be carefully backfilled with sand to a depth of 12 inches above the top of the pipe. Refer to appropriate Sections of Division 31 for additional requirements.
   2. Backfill under concrete slabs-on-fill shall be as per appropriate Sections of Division 31.

M. Opening and Reclosing Pavement and Lawns: Where excavation requires the opening of existing walks, streets, drives, other existing pavement, or lawns, such surfaces shall be cut as required to install new lines and to make new connections to existing lines. Refer to Division 31. The sizes of the cut shall be held to a minimum, consistent with the work to be accomplished.

N. Excavation in Vicinity of Trees: Refer to Division 31.

O. Welding Certificates: Provide current welding certificates.

1.13 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, “Structural Welding Code--Steel.”
B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Furnish new and unused materials, pipes, pipe fittings, and equipment of domestic manufacturer where available. Where two or more units of same type or class of equipment are required, provide units of a single manufacturer.

2.2 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers are listed in individual Sections of Division 22. Manufacturer's names and catalog numbers specified under Sections of Division 22 are used to establish standards of design, performance, quality and serviceability and not to limit competition. Equipment of similar design, equal to that specified, manufactured by a manufacturer named in the acceptable manufacturer's list will be accepted upon approval.

B. Substitutions:
   1. If the Contractor desires to substitute a material or method as an equal to the specified item, he shall request permission from the Architect/Engineer, in writing, and shall include such literature, samples, etc., deemed necessary to establish the equal quality of his proposal.
   2. If the Architect/Engineer deems it necessary in order to establish the equality between two or more products, he may require laboratory testing at the Contractor's expense in order to obtain information upon which to base a decision.
   3. The Architect/Engineer will not give approval to material salesmen or subcontractors and only in writing to the successful Contractor after the project has been awarded.
   4. For each proposed substitution product, clearly show how the proposed product meets the requirements of the specifications, including performance.
   5. No substitution will be considered unless it is presented in writing within that number of days after Notice to Proceed equal to 15 percent of the contract time.
   6. Proposers of substitute products shall present samples, literature, test and performance data, record of other installations, names of Owners, architects, engineers, contractors and subcontractors as references, statement of current financial condition, and other technical information applicable to their products, to aid in determining the worth of the substitute product offered in relation to the material and work specified from the standpoint of the Owner's best interest.
   7. Substitute materials and products shall be used only if approved in writing by the Architect/Engineer in advance.
8. Approval of substitute materials offered shall not be a basis for contingent extra charges because of changes in other work or related work, such as roughing-in, electrical, structural, or architectural, which may result from the substitution.

9. For any Contractor initiated substitutions or changes, Contractor shall be responsible for achieving results equal to or better than the product or design originally specified.

2.3 PIPE STRAINERS

A. Immediately prior to final acceptance of project, inspect, clean and service piping system strainers.

B. Turn over to Owner additional sets of spare parts as specified.

2.4 FLAME SPREAD PROPERTIES OF MATERIALS

A. Materials and adhesives incorporated in this project shall conform to NFPA Standard 255, "Method of Test of Surface Burning Characteristics of Building Materials" and NFPA 90. The classification shall not exceed a flame spread rating of 25 for all materials, adhesives, finishes, etc., specified for each system, and shall not exceed a smoke developed rating of 50.

2.5 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.6 JOINING MATERIALS

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

B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8” Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.

E. Welding Filler Metals: Comply with AWS D10.12.

F. Solvent Cements for Joining Plastic Piping:

1. ABS Piping: ASTM D 2235.
2. CPVC Piping: ASTM F 493.
3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
4. PVC to ABS Piping Transition: ASTM D 3138.
2.7 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180°F.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225°F.

F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225°F.

2.8 MECHANICAL SLEEVE SEALS

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

B. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

C. Pressure Plates: Stainless steel. Include two for each sealing element.

D. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.9 SLEEVES

A. Through Floors: Galvanized schedule 40 steel pipe sleeve with water ring, as detailed.

B. Through Walls in Crawl Space: Galvanized schedule 40 steel pipe sleeve with water ring, as detailed.

C. Sleeves Through Interior Walls: 22 gauge galvanized steel snap lock. No screws through vapor barrier.

2.10 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
C. One-Piece, Cast-Brass Type: With set screw.
   1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   1. Finish: Polished chrome-plated.

2.11 GROUT
A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS
A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.
L. Install escutcheons for penetrations of walls, ceilings, and floors.

M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1" annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Install steel pipe for sleeves smaller than 6 inches in diameter.
   2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
   3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1 inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section, Penetration Firestopping, for materials.

Q. Verify final equipment locations for roughing-in.

R. Refer to equipment specifications in other Sections for roughing-in requirements.

S. Provide fire rated type access panels in fire rated walls where indicated in drawings. Access panel to match or exceed to wall rating.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402, for safe-handling practice of cleaners, primers, and solvent cements.
   2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
   3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
   4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
   5. PVC Nonpressure Piping: Join according to ASTM D 2855.
   6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

3.3 PIPING CONNECTIONS

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

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.5 OBSTRUCTIONS

A. Drawings indicate certain information pertaining to surface and subsurface obstructions which has been taken from available drawings. Such information is not guaranteed, however, as to accuracy of location or complete information.

B. Before any cutting or trenching operations are begun, verify with Owner's Representative, utility companies and other interested parties that all available information has been provided. Verify locations given.

C. Should obstruction be encountered, whether shown or not, alter routing of new work, reroute existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing services and structures in a satisfactory and serviceable condition.

D. Assume total responsibility for and repair any damage to existing utilities or construction.

3.6 OPENINGS

A. Framed, cast or masonry openings for ductwork, equipment and piping are specified under other divisions. However, drawings and layout work for exact size and location of all such openings are included under this division.

3.7 PROTECTION

A. Adequately protect work, equipment, fixtures and materials from damage during storing, installation, start-up and testing.

B. Cover all equipment stored exposed to elements with waterproof tarps. Provide adequate ventilation. At work completion, all work must be clean and in like new condition.

C. Storage of all mechanical equipment and piping materials shall be in strict accordance with manufacturers written installation instructions.

D. Provide factory installed pipe caps for all pipes to be installed on the project.
3.8 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

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

3.9 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section, Metal Fabrications, for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.10 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.11 GROUTING

A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.
F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

3.12 LUBRICATION AND OIL

A. Provide a complete charge of correct lubricant and/or oil for each item of equipment requiring lubrication.

3.13 TEMPORARY CONDITIONING OF BUILDING SPACES FOR COMPLETION OF CONSTRUCTION

A. All equipment utilized will be checked out by a factory representative, serviced, lubricated, checked for rotation, pressure, amp draw and vibration isolation, adjusted and certified. Record of this service must be provided monthly to the Owner. Submit appropriate reports to the University prior to submitting a written request for service.

B. All equipment operated shall be serviced on a regular basis by the Contractor.

C. Prior to final inspection, clean all equipment inside and out to a like new condition, remove temporary filters, install new permanent filters in preparation for final inspection by Owner.

D. All warranties will be commenced at the time of final acceptance.

3.14 OPERATING TESTS

A. After all plumbing systems have been completed and put into operation, subject each system to an operating test under design conditions to ensure proper sequence and operation throughout the range of operation witnessed by Owner’s Representative.

B. Prove operations of control systems and all safeties, and alarms. Make adjustments as required to ensure proper functioning of all systems. Special tests on individual systems are specified under individual Sections.

C. Functional Performance Testing is part of the Commissioning Process. Functional performance testing shall be performed by the Contractor and witnessed and documented by the Commissioning Agent. Refer to Section 01 9113, General Commissioning, for functional performance testing and commissioning requirements.

3.15 OPERATING AND MAINTENANCE INSTRUCTIONS

A. The Contractor shall furnish five copies of commercially available standard operation and maintenance data, including operating instructions, maintenance instructions and parts listings. Detailed requirements for these items are as follows:

1. Information required for the preparation of O&M manuals may be furnished in the form of manufacturers’ standard brochures, schematics, and other printed instructions. Clearly
distinguish between information which applies to the equipment and information which does not apply. Data shall include as a minimum the following items:

2. Recommended procedures and frequencies for preventive maintenance; inspection, adjustment, lubrication, cleaning, etc.
3. Special tools and equipment required for testing and maintenance.
4. Parts lists reflecting the true manufacturer's name, part number and nomenclature.
5. Recommended spares by part number and nomenclature and spare stocking levels.
6. Integrated mechanical and electrical system schematics and diagrams to permit operation and troubleshooting after acceptance of the system.
7. Troubleshooting, checkout, repair and replacement procurement procedures.
8. Operating instructions including start up and shutdown procedures.
9. Safety considerations including load limits, speed, temperature and pressure.
10. Provide O&M manuals for all plumbing equipment. Coordinate requirements for O&M Manuals with Division 01.

3.16 OPERATING INSTRUCTIONS

A. Upon completion of work, and at time designated by the Owner's Representative, provide services of a competent representative of the Contractor for a period of at least 40 hours to instruct the Owner's Representative in the operation and maintenance of the entire system. The training sessions will be video taped for instructing future technicians.

B. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner's Representative. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the Owner's Representative after submission and approval of formal training plans. Refer to Section 01 9113, General Commissioning, for contractor training requirements.

C. Coordinate requirements for training with Division 01.

END OF SECTION
SECTION 22 0526

PIPE AND PIPE FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes requirements for pipe and pipe fittings for all piping systems. This Section applies to all Plumbing Sections of Division 22 which employ pipe and pipe fittings. Fabricate and erect all piping in accordance with ASME/ANSI B31.9 except as otherwise indicated.

1.2 RELATED SECTIONS

A. Division 07 – Thermal and moisture protection for firestopping requirements.
B. Division 09 – Finishes for painting requirements.
C. Section 22 0500 – Common Work Results for Plumbing
D. Section 22 0553 - Identification for Plumbing Piping and Equipment.
E. Section 22 0548 - Vibration Isolation for Plumbing Piping and Equipment.
F. Section 22 0716 - Plumbing Equipment Insulation.
G. Section 22 1116 - Domestic Water Piping.
H. Section 22 1119 - Domestic Water Piping Specialties.
I. Section 22 1423.13 - Roof Drainage Piping Systems.

1.3 SUBMITTALS

A. Welding certificates.

1.4 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 paragraphs where titles below introduce lists or manufacturers, the following requirements apply to product selection:

1. Acceptable Manufacturers: Subject to compliance with requirements, provide products by the manufacturer specified.

2.2 PIPE AND FITTINGS

A. The particular type of pipe and fittings for each system is specified in the Section for that system. All piping and fittings shall be of U.S. Manufacturer. All pipe shall be shipped capped. Shipped and store on job site with ends capped from the factory.

2.3 JOINTS

A. Screwed: Make screwed joints using machine-cut ANSI taper pipe threads. Apply a suitable joint compound, such as Teflon tape, to the male threads only. Ream the pipe to full inside diameter after cutting. All-thread nipples are not permitted.

B. Dissimilar Metals: Make joints between copper and steel pipe and equipment along with steel pipe and ductile iron pipe using insulating unions such as Crane Company No. 1259; EPCO as manufactured by EPCO Sales, Inc.; or an approved equal.

C. Solder Joints:

1. Prior to making joints, cut pipe square and ream to full diameter. Clean exterior of pipe and socket. Apply a thin coat of suitable fluxing compound to both pipe and socket, and fit parts together immediately.

2. Heat assembled joint only as required to cause the solder to flow. Run the joint full, slightly beaded on the outside, and wipe to remove excess solder.

3. Utilize lead free solder. Use silver brazing alloy or Sil-Fos on refrigerant piping and on underground piping.

D. Welded Joints:

1. Make welded joints as recommended by the standards of the American Welding Society.

2. Ensure complete penetration of deposited metal with base metal.

3. Provide filler metal suitable for use with base metal.

4. Keep inside of fittings free from globules of weld metal.

5. Do not use mitered joints.

6. Use standard weld elbow fittings for changes of direction or cut a standard elbow for odd angles.
E. Flanged Joints:

1. Prior to installation of bolts, accurately center and align flanged joints to prevent mechanical prestressing of flanges, pipe and equipment. Align bolt holes to straddle the vertical, horizontal or north-south centerline. Do not exceed 3/64 inch per foot inclination of the flange face from true alignment.

2. Use flat-face companion flanges only with flat-faced fittings, valves or equipment. Otherwise, use raised-face flanges.

3. Install proper gaskets, suitable for intended service and factory cut to proper dimensions. Red rubber gaskets are not acceptable. Garlock gaskets or EPDM shall be used. Apply non-stick clean surface lubricant coating to both sides of gaskets.

4. Use ANSI nuts and bolts, galvanized or black to match flange material. Use Coreten or galvanized steel nuts and bolts underground. Tighten bolts progressively to prevent unbalanced stress. Draw bolts tight to ensure proper seating of gaskets. Use anti-seize compound on all bolts above and below grade. Bolt threads not to protrude more than 2 threads past nut.

5. Use carbon steel flanges conforming to ANSI B16.5 with materials conforming to ASTM A 105, Grade II or ASTM A 108, Grade II. Use welding neck type flanges at all fittings and on all pipe.

6. Flanges for ductile iron pipe are specified in Sections using that pipe.

7. Keep flange covers on equipment and shop-fabricated piping until ready to install in system.

F. No Hub: Install according to manufacturer's recommendations, using recommended tools.

G. Bell and Spigot: Use neoprene compression gaskets for sanitary and storm.

H. Push-on Joints (Ductile Iron Pipe): Restrained joints and gaskets for ductile iron pipe are specified in Sections using that pipe.

2.4 UNIONS

A. Use 150-pound standard (300-pound WOG) malleable iron, ground joint unions with bronze seat. Provide flanged union joints on piping larger than 2-1/2 inches.

2.5 BRANCH CONNECTIONS

A. For Pipe 2 inches and smaller, use threaded fittings for steel pipe. For threaded piping, use straight size of reducing tee.

B. For 2-1/2 Inches through 14 Inches: For welded piping, when branch size is the same as and one size smaller than header size, use welding tee. Use Weld-O-Let when branch is two or more sizes smaller than header. For threaded branch connections, use thread-o-let welded to header.

C. All changes in direction, branches, offsets etc., shall be made with standard pipe fittings. Holes in the main for branches shall be made with a hole cutting machine and a standard "Weld-O-Let" or 'Thread-O-Let' fitting used. Burning holes in the system piping will cause that section of the piping to be cut out and replaced at the Contractor's expense.
2.6 GASKETS

A. Provide gaskets between flanges of all flanged joints. Inside diameter of gaskets shall conform to nominal pipe size. Gaskets shall be ring type between raised face flanges and full face between flat face flanges with punched bolt holes and pipe opening.

B. Gaskets shall be cut from 1/8 inch thick non-metallic, non-asbestos gasket material suitable for operating temperatures from -150°F to +750°F. Garlock or equal. For pipe smaller than 6 inches, use 1/16-inch-thick gasket.

2.7 FLOOR AND CEILING PLATES

A. Provide chrome-plated floor and ceiling plates around pipes exposed to view and passing through walls, floors, partitions, or ceilings in finished areas. Size plates to fit pipe or insulation and securely lock in place.

PART 3 - EXECUTION

3.1 PIPE FABRICATION AND INSTALLATION

A. Make piping layout and installation in the most advantageous manner possible with respect to headroom, valve access, opening and equipment clearance, and clearance for other work.

B. Give particular attention to piping in the vicinity of equipment. Preserve the maximum access to various equipment parts for maintenance. Install piping plumb and parallel with building walls.

C. Do not cut or weaken any structural member.

D. Cut all pipes accurately to measurement determined at the site. After cutting pipe, ream it to remove burrs.

E. Install piping neatly, free from unnecessary traps and pockets. Work into place without springing or forcing. Use fittings to make all changes in direction. Field bending and mitering are prohibited. Make all connections to equipment using flanged joints or unions. Make reducing connections with reducing fittings only.

F. All water piping installed above ground or below ground and in trenches, including preinsulated piping, must be installed by a licensed Mechanical Contractor at building rates. The wage rates for building trades apply only to the extent of work required to be installed by licensed Plumbing or Mechanical Contractors.

3.2 WELDING

A. Weld and fabricate piping in accordance with ANSI Standard B31.9, latest edition, Code for Pressure Piping. Machine beveling in shop is preferred. Field beveling may be done by flame cutting to recognized standards.

B. Align piping and equipment so that no part is offset more than 1/16 inch. Set all fittings and joints square and true, and preserve alignment during welding operation. Use of alignment rods inside pipe is prohibited.
C. Do not permit any weld to project within the pipe so as to restrict it. Tack welds, if used, must be of the same material and made by the same procedure as the completed weld. Otherwise, remove tack welds during welding operation.

D. Do not split, bend, flatten or otherwise damage piping before, during or after installation.

E. Remove dirt, scale, and other foreign matter from inside piping before tying in sections, fittings, valves or equipment.

3.3 OFFSETS AND FITTINGS

A. Because of the small scale of Drawings, the indication of all offsets and fittings is not possible. Carefully investigate the structural and finish conditions affecting the work and take such steps as may be required to meet such conditions.

B. Install all piping close to walls, ceilings, and columns so piping will occupy the minimum space. Provide proper space for covering and removal of pipe, special clearances, and for offsets and fittings.

3.4 PIPE SLEEVES

A. Fit with sleeves all pipes passing through gyp board, masonry, and concrete construction, refer to specification section 22 0500 and the following:

1. Provide 20 gauge wall sleeves for pipes passing through gyp board walls.
2. Fabricate floor sleeves of schedule 40 weight galvanized steel pipe and masonry wall sleeves of 20 gauge galvanized steel.
3. Size sleeve for minimum clearance between pipe or insulation and sleeve.
4. All sleeves in wet lab areas to have a welded waterstop.
5. All sleeves shall be hot dipped galvanized after fabrication.

B. Extend each sleeve through the floor or wall. Cut the sleeve flush with each surface, except that in exposed locations, extend floor sleeves 2 inches above finished floor line.

C. Seal all sleeves water and airtight. Seal annular space between pipes and sleeves with compound with flame and smoke spread rating of minimum 25/50 in accordance with ASTM E 84 test.

D. Sleeves below grades in outside walls are detailed on drawings. Except as shown otherwise, provide Thunderline Link-Seal or approved equivalent with stainless steel nuts and bolts, with cast iron pressure plate.

3.5 ISOLATION VALVES

A. Provide piping systems with line size shutoff valves located at the risers, at main branch connections at each floor and at branch takeoffs serving all equipment, and at other locations as indicated and required for isolation of piping or equipment.
3.6 DRAIN VALVES AND VENTS

A. Install drain valves at all low points and at base of all risers of water piping systems so that these systems can be entirely drained. Install a 2 inch drain for 2-inch pipes and larger. Install a line size drain valve for pipes smaller than 2 inches. Provide hose adapter and cap on all drain lines.

B. Provide automatic vents with isolation valves or manual vents at locations as indicated on drawings and all high points in piping systems.

3.7 CLEANING OF PIPING SYSTEMS

A. Cleaning of piping system must be performed by an independent agency specializing in this type of work:

1. The agency must have a minimum of 5 years’ experience with at least three projects of similar size.
2. Submit project names for review.

B. Minimum velocity of 10 feet per second must be maintained in the pipes during flushing period:

1. Do not use building pumps for circulating water.
2. Provide temporary pumps as required to achieve minimum velocities.
3. Remove flow meters from building piping during flushing operation.
4. Provide means ( instrumentation) during flushing period to prove to the Owner that the minimum velocities are maintained in the pipes.

C. Submit a detailed plan for the Engineer’s and Owner’s review and approval describing in full detail the individual steps associated with this process before any piping is installed:

1. Plan must include a drawing indicating GPM’s required to provide minimum velocity required in the piping, phasing of systems being cleaned, locations of drains or other temporary connections required for cleaning system, and cutsheet of temporary pump proposed.

D. Clean piping systems thoroughly. Purge pipe of construction debris and contamination before placing the systems in service. Provide temporary connections and valves as required for cleaning, purging and circulating.

E. Install temporary strainers in front of pumps, tanks, water still, solenoid valves, control valves, and other equipment where permanent strainers are not indicated. Keep these strainers in service until the equipment has been tested, then remove either entire strainer or straining element only. Fit strainers with a line size blowoff valve.

F. Domestic Water Piping:

1. All potable water piping and tanks shall, after successful pressure testing, be thoroughly flushed with clear water and then sterilized.
2. Sterilization shall be with either liquid chlorine or chlorine gas of adequate volume to give a concentration of 50 ppm based upon the volume of the system being treated.
3. The solution will be allowed to stand for a period of 24 hours.
4. A minimum residual chlorine level of 5 ppm shall remain in each system for a minimum of 24 hours.
5. After sterilization, all piping shall be thoroughly flushed.
6. The above are minimum requirements and all sterilization procedures shall be in strict accordance with all local codes and authorities having jurisdiction.
7. Under no circumstances shall the Contractor permit the use of any portion of the domestic water system until it has been properly sterilized and certified by the authorities having jurisdiction.

G. Special requirements, if any, are specified in the Sections for each type of piping.

H. After systems have been flushed, cleaned and sterilized; as required by specifications, provide written certification from the cleaning contractor that the systems are clean and ready for use.

3.8 LEAK TESTS

A. All piping systems shall demonstrate leak tightness. This requirement shall be met by a water hydrostatic leak test or a pneumatic leak test, whichever is called for under specific piping Sections.

B. Piping Systems:

1. Test Preparation: Expansion joints shall be provided with temporary restraint, for the additional pressure load under test or shall be isolated from the test. Equipment and valves which are not rated for the pressure test shall be either disconnected from the piping or isolated by a blind flange or similar means.
2. Test Pressure: The water hydrostatic test pressure shall be 1.5 times the design pressure. The pressure test shall be maintained for sufficient time to inspect all joints, with a minimum time of four hours.
3. Special requirements, if any, for each system are specified in the Section for that system.

3.9 CONNECTIONS TO EQUIPMENT FURNISHED BY OTHERS

A. Provide service connections to items of equipment furnished by others:

1. Detailed shop drawings of equipment will be furnished indicating the exact number and location of rough-in points.
2. Such final shop drawings may indicate adjustments in total number and exact location of rough-in points, and in equipment dimensions.
3. Making adjustments to field conditions is considered a part of the work required.

B. Roughing-In:

1. When roughing-in, extend service piping to various items of equipment.
2. Temporarily terminate at proper points as indicated on detailed equipment shop drawings or as directed.
3. Do not use contract drawings accompanying these specifications for rough-in locations but only for pipe sizing and general routing.

C. Stop Valves:

1. Provide stop valves for each service at rough-in locations, except for drains.
2. Stop valve locations are subject to approval, and in all cases must be accessible from the same room in which the furniture or equipment is located.
3.10 TEMPORARY CONDITIONING OF BUILDING SPACES FOR COMPLETION OF CONSTRUCTION

A. Refer to Specification 22 0500.4, Common Work Results for Plumbing, for requirements that must be completed prior to requesting the Owner to provide chilled water or hot water from the building distribution system.

3.11 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION
SECTION 22 0529
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Steel pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Thermal-hanger shield inserts.
   5. Fastener systems.
   6. Equipment supports.

B. Division 03 Section, Concrete, for concrete requirements.

C. Division 05 Section, Metal Fabrications, for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

D. Division 09 Section, Painting, for painting requirements.

E. Section 21 1300 - Fire-Suppression Systems, for pipe hangers for fire-suppression piping.

F. Section 22 0500 – Common Work Results for Plumbing

G. Section 22 0548 - Vibration Isolation for Plumbing Piping and Equipment, for vibration isolation devices.

1.2 DEFINITIONS

A. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
1.4 SUBMITTALS

A. Product Data: For the following:
   1. Steel pipe hangers and supports.
   2. Thermal-hanger shield inserts.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
   1. Trapeze pipe hangers. Include Product Data for components.
   2. Metal framing systems. Include Product Data for components.
   3. Equipment supports.

C. Welding certificates.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Anvil
B. Cooper B-Line
C. Erico
D. Unistrut
E. Nibco
F. PHP

2.2 CLEVIS TYPE HANGERS

A. Adjustable steel clevis hangers (MSS1 Type 1), similar to Anvil Figure 260.

2.3 METAL FRAMING SYSTEMS

A. Provide fabricated cadmium plated steel framing members and appurtenances for interior pipe supports as shown:
   1. Mult-A-Frame, Unistrut, Cooper B-Line and Power-Strut pipe support systems also are acceptable.
   2. Support piping from precast and pan joist structure as detailed on Drawings.
3. Powder actuated anchors are not permitted.
4. Sleeves penetrating beams must be submitted through Structural Engineer. Refer to plumbing drawings for locations.

B. Framing channel type support systems shall be 12-gauge cold-formed carbon steel conforming to ASTM A570 GR33:

1. Fittings for framing channel system shall be punch pressed electro-galvanized carbon steel conforming to ASTM A575, A576, A635 and A36.
2. Bolts and nuts shall have unified coarse screw threads with standard 1/2 inch nuts, conforming to ASTM A576 GR1015 AND ASTM A307.
3. Components shall have an electro-plated zinc coating conforming to ASTM B633 SC1 or SC3, except where outdoors where a hot dipped galvanized coating conforming to ASTM A123 shall be used.

2.4 TRAPEZE PIPE HANGERS

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

2.5 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier with vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.
2.8 MISCELLANEOUS MATERIALS

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

B. Concrete: Provide 3,000 psi concrete. Reinforce slab with No. 4 rebar on 12 inch center each way centered in slab unless indicated otherwise on Drawings.

C. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.

2.9 SUPPORTS AND HANGERS WITHIN WALLS AND CHASES

A. Where plumbing piping is located in walls and chases it shall be supported and clamped with factory supplied commercial support assemblies, inserts and clamps as manufactured by Holdrite, or approved equal.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Metallic coatings for piping and equipment that will not have field-applied finish. All hangers and supports shall be electro-plated zinc per ASTM B633 SC1 or SC3, except hangers, framing channels, supports and other associated hardware in crawl space shall be hot dipped galvanized conforming to ASTM A123.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.

F. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
   2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120°F to 450°F piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
   a. Light (MSS Type 31): 750 lb.
   b. Medium (MSS Type 32): 1500 lb.
   c. Heavy (MSS Type 33): 3000 lb.
8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.

L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

O. All exposed hangers and supports within areas with wash down hoses and areas where washdown can occur, shall have a hot dipped galvanized finish.

P. Supports and hangers for piping within Greenhouse shall be type 316 stainless steel.

3.2 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified herein for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:
   1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.


H. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

I. Install lateral bracing with pipe hangers and supports to prevent swaying.

J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

K. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

M. Insulated Piping: Comply with the following:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      c. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.
   2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   4. Shield Dimensions for Pipe: Not less than the following:
      a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
      b. NPS 4: 12 inches long and 0.06 inch thick.
      c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
      d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
      e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
   5. Pipes NPS 8 and Larger: Include wood inserts.
   6. Insert Material: Length at least as long as protective shield.
   7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

N. Do not support piping from other piping.

O. Where uninsulated (bare) copper pipe is supported by clevis hangers and riser clamps. The hangers shall be plastic coated or copper.

P. Where uninsulated (bare) copper pipe is clamped to a dissimilar metal, such as steel, the copper pipe shall be installed with a felt isolator or Vibra Cushion No. B1999 manufactured by B-Line, Erico “Caddy” Cushion Clamp, or approved equal.

Q. Isolation tape wrap is only acceptable where a clamp or support does not occur and where pipe is in connect with a building element.

R. Place hangers not more than 6 feet apart on 1/2 inch and 3/4 inch pipes, or 10 feet apart on larger pipes unless noted otherwise on plans. Place hangers not more than 6 feet apart for all sizes of polyvinyl chloride pipe. Refer to manufacturer’s recommendations for supporting polypropylene piping. For copper piping, place hangers as follows:
   1. For sizes up to 1 inch – maximum 5 feet - 0 inches O.C.
   2. For sizes 1-1/4 inch to 1-1/2 inch – maximum 7 feet - 0 inches O.C.
   3. For sizes 2 inches to 3 inches and larger – maximum 9 feet - 0 inches O.C.

S. Support vertical risers as detailed on drawings at every floor:
   1. All water piping 2 inches or smaller shall be supported with galvanized steel strap pipe clamps of approved designed and sizes, properly supported at every floor.
2. Support piping assemblies in chases adequately enough to be rigid and self-supporting before the chase is closed.
3. Provide adequate structural support for piping penetrating chase walls to fixtures.

T. Where insulation occurs, design hangers to protect insulation from damage. Pipe saddles and insulation shields, where required, are specified in the appropriate insulation Section.

U. Perforated bar hangers, straps, wires or chains are not permitted.

V. For cast iron piping, refer to specification section 22 1316.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.6 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION
SECTION 22 0548

VIBRATION ISOLATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for furnishing, installing, and adjusting vibration isolation, including bases of structural steel and concrete, with steel pouring forms and reinforcing bars for concrete.

B. Related Sections Include:
   1. Section 22 0500 - Common Work Results for Plumbing
   2. Section 22 0529 - Hangers and Supports for Plumbing Piping and Equipment.
   4. Section 22 1123 - Pumping Pumps
   5. Section 22 1619 - Compressed Air Systems
   6. Section 22 6219 - Laboratory Vacuum Systems

1.2 SUBMITTALS

A. Product Data: Submit product data showing type, size, load, deflection, and other required information. Include clearly outlined procedures for installing and adjusting isolators. Submit Drawings for each item of equipment with complete isolation installation information.

B. Submit detailing of inertia bases and locations of vibration isolators indicating static and dynamic load on each isolator.

C. Design Data: Provide schedule of vibration isolator type with location and load on each. Include data on each isolator type that corresponds to the following:
   1. Spring diameter.
   2. Deflection.
   3. Compressed spring height.
   4. Solid spring height.
   5. Point location of each isolator.
   6. Calculated load at each point.
   7. Field static deflection.

D. Delegated-Design Submittal: For vibration isolation calculations and details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified Professional Engineer responsible for their preparation.

E. Welding certificates.

F. Qualification Data: For Professional Engineer.

G. Field quality-control test reports.
1.3 QUALITY ASSURANCE
   A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Acceptable Manufacturers: Subject to compliance with requirements provide products by one of the following:
      1. Amber/Booth Company, Inc.
      2. Korfund.

2.2 ISOLATOR DESIGN
   A. Materials:
      1. Design and treat vibration isolators for resistance to corrosion.
      2. Furnish phosphatized steel components with industrial-grade, corrosion-resistant enamel.
      3. Coat components exposed to the weather with PVC coating or fabricate of galvanized steel.
      4. Furnish zinc-electroplated nuts, bolts, and washers.
      5. Clean steel bases thoroughly of welding slag and prime with zinc chromate or metal etching primer.
      6. Provide corrosion resistant coating on all isolators exposed to weather conditions.
   B. Design:
      1. The isolator manufacturer must calculate the amount of spring deflection required for each isolator to achieve optimum performance and to prevent the transmission of objectionable vibration and noise.
      2. Isolators must be sized for starting torque of equipment motors.
3. The following minimum spring deflections apply:

<table>
<thead>
<tr>
<th>Motor Size Horsepower</th>
<th>Installation Above Grade</th>
<th>Installation at Grade or Below</th>
</tr>
</thead>
<tbody>
<tr>
<td>BELT DRIVEN EQUIPMENT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 – 10</td>
<td>3/4”</td>
<td>3/4”</td>
</tr>
<tr>
<td>15 – 30</td>
<td>1-1/2”</td>
<td>1”</td>
</tr>
<tr>
<td>40 – 75</td>
<td>2”</td>
<td>1-1/2”</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DIRECT DRIVEN EQUIPMENT</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5 – 20</td>
<td>3/4”</td>
<td>3/4”</td>
</tr>
<tr>
<td>25 – 72</td>
<td>1”</td>
<td>3/4”</td>
</tr>
</tbody>
</table>

4. All spring isolators must be completely stable in operation and must be design for not less than 30 percent reserve deflection beyond actual operating conditions.

5. Isolate equipment driven by motors of 2 horsepower and smaller by means of Amber-Booth Type RVD elastomeric mounts or Amber-Booth Type BRD elastomeric hangers.

6. Height saving brackets used with isolators having 2-1/2 inch deflection or greater shall be of the precompression type to limit exposed bolt length.

2.3 ISOLATOR TYPES

A. Design of isolator types listed is based on model numbers manufactured by Amber-Booth unless otherwise indicated. Subject to compliance with requirements provide named product.

B. Type SW: An adjustable, freestanding, open-spring mounting with combination leveling bolt and equipment fastening bolt. The spring mounting to base plate and compression plate must be rigid. A neoprene pad with a minimum thickness of 1/4 inch is bonded to the base plate. A minimum horizontal-to-vertical spring rate of 1.0 is required.

C. Type BS: A spring hanger consisting of a rectangular steel box, coil spring, spring retainers, neoprene-impregnated fabric washer, and steel washer.

D. Type PBS: A spring hanger as described for Type BS with the addition of a load transfer plate to hold the equipment or piping at a fixed elevation during installation and to permit transferring the load to the spring after installation.

E. Type SP-NRE: A pad-type mounting consisting of two layers of 3/8 inch thick ribbed or waffled neoprene pads bonded to a 16-gage galvanized steel separator plate. Size pads for approximately 20 to 40 psi load and a deflection of 0.12 to 0.16 inch.
2.4 ISOLATOR APPLICATIONS

A. Pumps

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Isolator Type / Minimum Deflection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 3 HP</td>
<td>SP-NRE</td>
</tr>
<tr>
<td>5 HP and Over</td>
<td>SP-NRE</td>
</tr>
</tbody>
</table>

2.5 FLEXIBLE PIPING CONNECTIONS AT PUMPS

A. Unit shall be rated at 225 psi and maximum temperature of 230°F.

B. Provide 150# flanges and galvanized aircraft cable control units.

C. Provide flexible connectors at domestic water pressure booster pumping package.

D. Provide flex connectors on pumping inlets and discharge flanges. Provide type 304 stainless steel corrugated hose and braid with Class 150 lb. floating stainless steel flanges, rated for a minimum of 190 psi at 70 degrees F, for domestic water service, manufactured by Mason-Mercer Model FFLSS, or approved equal.

E. Vacuum Pump and Air Compressor Systems: Provide braided stainless steel hose with bronze solder type end connectors, rated for a minimum 150 psi pressure for compressed air and vacuum service of minimum of 28 inch Hg. Manufactured by Mason Industries No. BBF, or approved equal.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger Rod stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

3.2 INSTALLATION

A. Isolation:

1. Isolate all pumped water piping 1-1/2 inches and larger within each mechanical equipment room.
2. Use Type PBS isolators for the first two hangers adjacent to isolated equipment and for all pipe 8 inches and larger.
3. Use Type BS isolators for all other hangers.
4. Floor supported piping shall be isolated with Type SW isolators.
5. The first two isolators adjacent to equipment shall have a deflection equal to the equipment isolation, but not to exceed 2 inches.
6. The remaining isolators shall be sized for 3/4 inch deflection.

B. Install full line size flexible connectors at the suction and discharge connection of each pump. All connectors to be suitable for use at the pressure and temperature encountered at point of operation.

C. Provide the following types of vibration isolators:

1. Type PBS for first two hangers in horizontal piping at equipment (except at connections to pipe risers: use BS).
2. Type BS for all but first two hangers in horizontal piping in mechanical rooms.
3. Type SW for first two supports of floor supported piping at equipment.

3.3 STOCK REQUIREMENTS

A. The isolation manufacturer's representative must maintain an adequate stock of springs and isolators of type used so that changes required during construction and installation can be made.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days’ advance notice.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
7. Measure isolator deflection.
8. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.5 ADJUSTING

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

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

END OF SECTION
SECTION 22 0553
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section Includes:
      1. Equipment labels.
      2. Warning signs and labels.
      3. Pipe labels.
      4. Stencils.
      5. Valve tags.
      6. Warning tags.

1.3 SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. Samples: For color, letter style, and graphic representation required for each identification material and device.
   C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
   D. Valve numbering scheme.
   E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION
   A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
   B. Coordinate installation of identifying devices with locations of access panels and doors.
   C. Install identifying devices before installing acoustical ceilings and similar concealment.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufactures: Subject to compliance with requirements, provide products by one of the following:

1. Brady Corporation.
2. Marking Services, Inc.

2.2 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: Black.
3. Background Color: Background to contrast with letter color.
4. Maximum Temperature: Able to withstand temperatures up to 160°F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 4 inches wide X 1-1/2 inches high.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Section number and title where equipment is specified.

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

2.3 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: Background to contrast with letter color.

D. Maximum Temperature: Able to withstand temperatures up to 160°F.
E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.4 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.


2. Paint: Standardized colors for the piping systems shall be per Division 09 painting specification. Paint material is based on colors and model numbers manufactured by Glidden unless otherwise indicated. Subject to compliance with requirements, provided named color or comparable product as approved. Use the following colors for banding of all piping and conduit:

<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>COLOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic Water, Cold, Hot or Hot Water Return, RO Water</td>
<td>Blue, comparable to ICI/Glidden #1330</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>Yellow (Paint entire pipe)</td>
</tr>
<tr>
<td>Compressed Air, Vacuum</td>
<td>White</td>
</tr>
<tr>
<td>Fire Water</td>
<td>Red</td>
</tr>
<tr>
<td>Drain Lines</td>
<td>Black, comparable to ICI/Glidden #1484</td>
</tr>
</tbody>
</table>

B. Standardized Sizes: Tags shall be at least 1-1/2 inches in diameter, with depressed block characters 1/4 inch high. Titles shall be lettered on bands. Uppercase letters and Arabic numerals shall be used. Where pipes or conduits are too small or not readily accessible for such application securely fasten a brass identification tag at appropriate locations. Identification of the material contained in piping and conduits in accordance with the table below:

<table>
<thead>
<tr>
<th>BAND AND LETTER SIZE ALL DIMENSIONS IN INCHES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside Diameter of Pipe Covering</td>
</tr>
<tr>
<td>----------------------------------------</td>
</tr>
<tr>
<td>1/2 to 1-1/4</td>
</tr>
<tr>
<td>1-1/2 to 2</td>
</tr>
</tbody>
</table>
1. **Pipe Identification:** Identify pipe at wall penetrations, machine or tank connections, and at not over 50 foot intervals. Marker identification shall be legible and should be visible from the floor. Stick-on type or plastic wrap-on markers are not acceptable. Mark each pipe circuit with stencil. Stencil shall include flow arrow and identification marks as follows:

<table>
<thead>
<tr>
<th>SERVICE</th>
<th>WORK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic Water Supply</td>
<td>Dom-W-S</td>
</tr>
<tr>
<td>Domestic Hot Water Return</td>
<td>Dom-HW-R</td>
</tr>
<tr>
<td>Domestic Hot Water Supply</td>
<td>Dom-HW-S</td>
</tr>
<tr>
<td>Storm Sewer</td>
<td>Storm</td>
</tr>
<tr>
<td>Overflow Drain</td>
<td>Overflow</td>
</tr>
<tr>
<td>Sanitary Sewer</td>
<td>San</td>
</tr>
<tr>
<td>Sanitary Vent</td>
<td>San-V</td>
</tr>
<tr>
<td>Lab Air (100 psi)</td>
<td>Air-100 psi</td>
</tr>
<tr>
<td>Lab Air (50 psi)</td>
<td>Lab-Air- 50 psi</td>
</tr>
<tr>
<td>Lab Vacuum</td>
<td>Lab-Vac</td>
</tr>
<tr>
<td>RO Water Supply</td>
<td>RO-W-S</td>
</tr>
<tr>
<td>RO Water Return</td>
<td>RO-W-R</td>
</tr>
<tr>
<td>Lab Waste</td>
<td>Acid-W</td>
</tr>
<tr>
<td>Lab Vent</td>
<td>Acid-V</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>Nat-Gas</td>
</tr>
</tbody>
</table>

2.5 **VALVE TAGS**

A. Valve Tags: Stamped or engraved with 1/4 inch letters for piping system abbreviation and 1/2 inch numbers.

1. **Tag Material:** Brass, 0.032 inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. **Fasteners:** Brass S-hook.

B. Valve Schedules: For each piping system, on 8-1/2 X 11 inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.
2.6 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: 3 X 5-1/4 inches minimum.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Equipment to be identified with plastic nameplates includes but is not limited to water heaters, filters, plumbing equipment, tanks, and water treatment devices.

B. Identify small devices, such as in-line pumps with metal tags.

C. Identify valves with tags.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Division 09 painting sections

B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels with painted, color-coded bands or rectangles, complying with ASME A13.1, on each piping system.

1. Identification Paint: Use for contrasting background.
C. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units.

B. List tagged valves in a valve schedule in aluminum frame with clear plastic shield. Install at location as directed by Owner’s Representative.

3.6 WARNING-TAG INSTALLATION

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

END OF SECTION
SECTION 22 0719

PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section Includes:

1. Insulation Materials:
   a. Fiberglass insulation.
   b. Closed Cell Elastomeric

2. Sealant, adhesives and finishes.
3. Jackets:
   a. PVC jackets.
   b. Canvas or glass jackets.
   c. Aluminum type jackets.

B. Related Sections include the following:

1. Section 22 0500 - Common Work Results for Plumbing
2. Section 22 0529 - Hangers and Supports for Plumbing Piping and Equipment.
3. Section 22 0534 - Domestic Hot Water Maintenance Tracing
4. Section 22 1116 - Domestic Water Piping Systems
5. Section 22 1316 - Sanitary Waste and Vent Piping
6. Section 22 1423.13 - Roof Drainage Piping Systems

1.2 REFERENCES


1.3 SUBMITTALS

A. Product Data: Provide product description, thermal characteristics, list of materials and thicknesses for equipment scheduled.

B. Shop Drawings:
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail attachment and covering of heat tracing inside insulation.
   3. Detail insulation application at pipe expansion joints for each type of insulation.
   4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
   5. Detail removable insulation at piping specialties, equipment connections, and access panels.
   6. Detail application of field-applied jackets.
   7. Detail application at linkages of control devices.
   8. Detail field application for each equipment type.

C. Samples: Submit samples of each type of insulation to display the material, quality, and application method.

   1. Obtain approval of sample application before proceeding with work.

D. Manufacturer’s Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

E. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

   1. Surface Burning Characteristics: Flame spread/smoke developed index of 25/50 maximum when tested in accordance with ASTM E 94, NFPA 255, or UL 723.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified with minimum 5 years’ experience.

C. Applicator Qualifications: Company specializing in performing the type of work specified with minimum 5 years of experience.
1.5 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer’s identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 - PRODUCTS

2.1 INSULATION

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Knauff Insulation.
3. Owens Corning.
4. Foster
5. Childers
6. Armacell: AP Armaflex
7. Aeroflex USA

B. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

C. Type A: Fiberglass (Glass Mineral Wool) Insulation; Bonded with a bio-based, formaldehyde free thermosetting resin. Type I, 850 deg. F (454 deg. C) or Type IV 1000 deg. F (538 deg. C). UL/ULC Classified per UL 723. Comply with ASTM C 585, ASTM C 411, ASTM C 795, and ASTM C 547, Type I, and Type IV, with k factor of 0.23 BTU/ft²/F/HR/inch at 75 degrees F.

1. Pipe insulation is designated by K factor; NOT density. The density typically ranges from 4 PCF to 7 PCF; depending on the size/thickness in order to meet the k curve value
2. Factory applied aluminum foil reinforced inner and paper outer factory covering. (All Service Jacket – ASJ+ or ASJ): with Self-Sealing Lap Closure System (SSL+ or SSL).
3. Additionally, provide hard aluminum metal jacket or reinforced aluminum foil jacket where indicated herein.
4. Knauff Earthwool 1000 Degree Pipe Insulation or approved equal.

D. Type B: Closed Cell Elastomeric

1. Thermal Conductivity: K-value of 0.28 BTU-In/Hr.-degree F or less at 75 degrees F.
2. Rated maximum service temperature of 300°F.
3. Rated as 25 flame spread and 50 smoke developed when tested in accordance with ASTM E84, UL 723, CAN/ULC-S102-M88 or NFPA 255.
4. Certified to meet the requirements of ASTM C795 for use over stainless steel.
5. Elastomeric products shall be supplied in a pre-slit tubular form with a pressure sensitive adhesive system for closure and vapor sealing of the longitudinal joint.
6. Shall meet or exceed requirements of ASTM C534, Type I, tubular grade.

2.2 SEALANT, ADHESIVE, AND FINISH

A. Type A Insulation (Fiberglass – Low Temperature (below 100°F):
   1. Sealant: Childers CP-34, CP-35, CP-30LO or Foster 95-44 elastomeric sealant at valve covers, anchors, and hangers.
   2. Adhesive: When pressure sensitive adhesive closures are not supplied or when additional vapor-retardant facings are to be applied, provide Foster 85-60 adhesive to seal longitudinal laps of the vapor barrier jacket and to adhere butt joint covers.
   3. Finish: Childers CP-34 or Foster 30-65 vapor retarder coating and Childers Chil Glas No 10 glass or Foster Mast a Fab polyester cloth.

B. Type A Insulation (Fiberglass – High Temperature (above 100°F):
   1. Adhesive: Foster 85-60 adhesive to seal longitudinal laps of the vapor barrier jacket and to adhere butt joint covers.
   2. Finish: Childers CP-10 or CP-11 or Foster 46-50 with No. 10 glass cloth. Alternately same mastic used in paragraph 2.2A may be used for consistency during application.
   3. Cement: Ramco Thermokote on insulated fittings, flanges, and valves.
   4. Sealant: Childers CP-50AMV1 diluted 50% in water to prime cement prior to applying coating.

C. Type B Insulation (Elastomeric):
   1. Adhesive: When factory applied pressure-sensitive closure is not available furnish Armaflex 520 BLV Low VOC Adhesive, Foster 85-75, or Childers CP-82 to seal longitudinal laps and to adhere butt joint covers.
   2. Finish: Furnish Aeroflex USA Aerocoat water based latex enamel finish or Foster 46-50 or Childers CP-11 coating.

2.3 FACTORY-APPLIED JACKETS

B. ASJ+: All Service Jacket composed of aluminum foil reinforced with glass scrim bonded to a white kraft paper interleaving with an outer polymer film leaving no paper exposed; complying with ASTM C 1136 Type I, II, III, IV, and VII.
C. ASJ: White, kraft paper, fiberglass reinforced scrim with aluminum foil backing; complying with ASTM C 1136, Type I.
D. ASJ-SSL: ASJ with self-sealing, pressure sensitive, acrylic based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
2.4 JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. Canvas or Glass Jackets, Indoor Only: UL listed cotton fabric, 6 ounce/square yard or low odor glass cloth, Childers 50AMV1 or Foster 81-42/30-36 lagging adhesive or approved equal.

C. Hard Aluminum Metal Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
   1. Piping: Prefabricated jacket of ASTM B 209 aluminum, 0.020 inches thick with factory applied 2 mil moisture barrier for finishing interior insulated pipe.
   2. Valves, Fittings, and Flanges: ASTM B 209 aluminum covers, 0.020 inches thick providing complete coverage of all valves, fittings, and flanges.
   3. Straps and Seals: 1 inch x 0.010 inch ASTM B 209 aluminum strapping and seals for applying aluminum jacket and covers to provide weather-tight covering of all insulation including caps, flanges, and end of lines.

D. Reinforced Aluminum Foil Jacket: Provide service reinforced vapor barrier jacket with integral laminated aluminum vapor barrier manufactured by Foster Vaporfas 62-05 or Venture Clad 1577CW.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install materials in accordance with manufacturer’s instructions.

B. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.

C. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.

D. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

E. Install insulation with longitudinal seams at top and bottom of horizontal runs.
F. Install multiple layers of insulation with longitudinal and end seams staggered.

G. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

H. Keep insulation materials dry during application and finishing.

I. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

J. Install insulation with least number of joints practical.

K. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

M. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3 inch wide strips of same material as insulation jacket.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap.
4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

N. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

P. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere and seal patches similar to butt joints.

Q. For piping systems being heat traced, provide insulation one pipe size larger to accommodate the heat tracing cable.

R. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
5. Handholes.
6. Cleanouts.

S. On piping where tracing will be installed the insulation size shall be 1 pipe size larger to accommodate the heat trace cable. Strictly follow the heat tracing system manufacturer's recommendations where insulating the piping system.

3.3 PIPING INSTALLATION

A. Complete pressure testing of piping systems prior to application of insulation.

B. Fiberglass Pipes: Butt insulation joints firmly together. Seal longitudinal laps and butt strips with sealant.

C. Fiberglass Low Temperature (below 100°F): Where piping is interrupted by fittings, flanges, valves or hangers, and at intervals not to exceed 25 feet on straight runs, form an isolating seal between the vapor barrier jacket and the bare pipe by liberal application of the sealant to the exposed joint faces carried continuously down to and along 4 inches of pipe and up to and along 2 inches of the jacket. Not required for storm piping or domestic water piping.

3.4 VALVES, FLANGES, AND FITTINGS

A. Fiberglass – Low Temperature (below 100°F):

1. Insulate valves, flanges, and fittings with pre-molded fitting secured with wire. Thickness of insulation shall be equal to that adjoining piping and shall match density or greater.
2. Finish with 1/4-inch layer of Foster 30-65 or Childers CP-34 reinforced with Foster Mast a Fab or Childers Chil Glass No. 10 glass/polyester fabric.

B. Fiberglass – High Temperature (above 100°F):

1. Omit insulation at screwed unions and at valves smaller than 1-1/2 inches.
2. On concealed (other than mechanical and pump rooms) piping, insulate fittings and valves 2-1/2 inches IPS and larger, with pre-molded or gored fitting covers. Thickness of insulation shall be equal to that of adjoining pipe. Finish with coating reinforced with white 10 inch x 10 inch glass fabric.
3. On concealed piping, insulate fittings and valves 2 inches IPS and smaller with mineral wool and insulating cement to a thickness equal to or greater than adjoining straight pipe. At Contractor's option, provide molded or mitered fittings, finished with Foster 46-50 or Childers CP-10/11 breather coating reinforced with glass fabric.
4. In exposed (mechanical, pump and equipment rooms) area, insulate all fittings, flanges and valves with molded or mitered fitting covers. Thickness of insulation shall be equal to that of adjoining pipe. Finish with breather coating reinforced with white glass fabric.

3.5 CONTROL VALVE COVERS - LOW TEMPERATURE SERVICE ONLY

A. Fabricate special covers, complete with troweled-on vapor seal, shaped to accommodate the valve stem. Insulation thickness shall be same thickness as adjoining pipe.
B. Seal covers to valve insulation proper with adhesive so that the seal may be broken with a knife blade without damage to either part. Arrange so that cover can be removed and replaced as necessary for operation of the valve. Finish valve cover with glass cloth and two coats of finish.

3.6 SHIELDS AND HANGERS

A. Where piping hangers or anchors must be in direct contact with pipe, seal off the pipe insulation on both sides of the hanger by carrying the vapor seal down to the bare pipe.

1. Apply insulation around the hanger ring or anchor and pipe and carry vapor barrier upward and outward along the hanger rod or anchor members to a point not less than 12 inches from the adjacent pipe.
2. Draw wire loops tight over the vapor barrier jacket, with ends of wire bent down. Take care to avoid puncturing the vapor seal.
3. Finish insulation as specified for flanges, and seal over adjacent vapor barrier jacket.

3.7 ALUMINUM TYPE JACKETING

A. Apply aluminum type jacketing jacket and covers according to manufacturer’s recommendations, completely encapsulate insulation on all piping, valves, flanges, reducers, etc.

B. Hard aluminum metal jacketing shall be installed using aluminum strapping and seals to provide complete weathertight covering. Provide hard aluminum jacket for all piping in mechanical rooms and mechanical penthouses within 84-inches of finished floor.

C. Provide aluminum foil jacketing in crawl spaces and in mechanical equipment rooms and mechanical penthouses above 84” from finished floor.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. All insulation applications will be considered defective Work if inspection reveals noncompliance with requirements.

3.9 INSULATION SCHEDULE

A. Provide insulation with thickness and conductivity values in compliance with ASHRAE Standard 90.1, but not less than thicknesses scheduled below:

<table>
<thead>
<tr>
<th>TYPE</th>
<th>PIPE SIZES</th>
<th>INSULATION THICKNESS- INCHES</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHU Condensate Drains</td>
<td>A</td>
<td>All Sizes</td>
</tr>
<tr>
<td>All Horizontal Storm and Overflow Drain Piping, including drain bodies extending to downspout shall be insulated.</td>
<td>A</td>
<td>All sizes</td>
</tr>
<tr>
<td>TYPE</td>
<td>PIPE SIZES</td>
<td>INSULATION THICKNESS- INCHES</td>
</tr>
<tr>
<td>------------</td>
<td>-------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>All Domestic Cold Water and Domestic Hot Water serving single fixtures.</td>
<td>A</td>
<td>1/2</td>
</tr>
<tr>
<td>Domestic Hot Water Supply and Return</td>
<td>A</td>
<td>1-1/2” and smaller</td>
</tr>
<tr>
<td>Domestic Hot Water Supply and Return</td>
<td>A</td>
<td>2” and larger</td>
</tr>
<tr>
<td>Drinking Fountain Drains</td>
<td>A</td>
<td>All sizes</td>
</tr>
<tr>
<td>Floor Drain Bodies and Drain Lines receiving AHU Condensate. Insulate from floor drain to a minimum 20’ of pipe run.</td>
<td>A</td>
<td>All sizes</td>
</tr>
<tr>
<td>All Domestic Cold Water, and Makeup Water</td>
<td>A</td>
<td>All sizes</td>
</tr>
</tbody>
</table>

1. Refer to floor plans for any additional locations for insulating piping due to acoustical concerns.
2. Vertical storm and overflow piping (downspouts) do not need to be insulated.

END OF SECTION
SECTION 22 1116
DOMESTIC WATER PIPING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes requirements for furnishing and installing domestic hot and cold water piping, including hot water return, makeup water within the building.

1.2 RELATED SECTIONS
A. Section 22 0553 - Identification for Plumbing Piping and Equipment.
B. Section 22 0500 - Common Work Results for Plumbing
C. Section 22 0719 - Plumbing Piping Insulation.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Field quality-control reports.

1.4 QUALITY ASSURANCE
A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
B. Comply with NSF 14 for plastic, potable domestic water piping and components.
C. Comply with UL classified in accordance with ANSI/NSF 61 for hot and cold potable water service and shall be certified to the low lead requirements of NSF-372 for potable domestic water piping and components. Manufacturer must provide written documentation of compliance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Acceptable Manufacturers: Subject to compliance with requirements provide indicated products by manufacturers listed.

1. Valves:
   a. Apollo.
   b. Crane.
   c. Nibco.
2. **Vacuum Breakers and Backflow Preventers:**
   a. Watts.
   b. Wilkins.
   c. Apollo

3. **Thermostatic Mixing Valves:**
   a. Lawler.
   b. Bradley.
   c. Powers.

### 2.2 PIPING AND FITTINGS

#### A. Aboveground (Including Trap Primer Piping):
Provide seamless, ASTM B 88, Type L copper water pipe with ANSI B16.22 wrought copper fittings with socket ends. Lead-free solder for all solder joints, Alloy Grade E in accordance with ASTM B32, similar to Engelhard Silvabrite 100. Joints for pipe fittings 2" and larger may be grooved type joints. Grooved End Fittings: All grooved end fittings shall be ANSI B16.18 cast bronze or ANSI B16.22 wrought copper, with copper-tube dimensioned grooved ends. (Flaring of tube or fitting ends to accommodate alternate sized couplings is not permitted.) Couplings shall consist of two ductile iron housing segments cast with offsetting angle-pattern bolt pads, pressure responsive grade EHP gasket, and zinc-electroplated steel bolts and nuts. Couplings shall be installation-ready, for direct stab installation without field disassembly. Victaulic Style 607. Flange Adapter Victaulic Style 641 roll grooved copper-tube dimensioned fittings sized 2" and larger. For pipe sizes 4" and less pressed type joints may be used instead of soldered type joints or grooved joints. Pressed type joints shall be Viega Pro-Press or ApolloXPress joining method with a non-toxic synthetic rubber elastomer seal (EPDM O-RINGS) with the fitting socket. The fitting shall be pressed under substantial pressure by power tool forming a joint rated for 200 psi and tested for 600 psi, approved by IAPMO IGC 137-99/PS 117-2000 & ANSI/NSF 61, fitting material shall conform to ANSI/ASM B16.22 & B16.18, approved by Uniform Plumbing Code. When pressed type fittings are used only one manufacturer components shall be used on the entire project, mixing fittings by different manufacturers is prohibited. 3/8" diameter copper tube is allowed only where serving a single lavatory with a 0.5 gpm flow control device.

#### B. Unions: ANSI B16.22 Class 150, 300-pound water-oil-gas service wrought solder joint fitting such as NIBCO 633/733 union C x C, or approved equal.

1. Flange joints larger than 2 inches shall be brass.
2. Provide dielectric isolating unions or connections between metallic piping of dissimilar metal.
3. Dielectric waterway fittings with grooved and/or threaded ends, as manufactured by Victaulic Company, Series 647, for sizes 1/2" through 8

### 2.3 VALVES

#### A. Comply with requirements in Section 22 1119, Domestic Water Piping Specialties, for balancing valves, drain valves, backflow preventers, and vacuum breakers.
B. Ball Valves (pipe sizes through 2 inches): 600 psi WOG, cast silicone bronze body, ASTM B584 Alloy C87600, two piece reinforced Teflon seats, full port, blowout proof stem, quarter turn handle with stainless steel ball and stem with threaded ends, manufactured by NIBCO No. T-585-66-LF or approved equal.

C. Check Valves:
   1. 2 inches and smaller: Class 125, horizontal swing silicone bronze disc, with bodies and caps conforming to ASTM B 584 Alloy 87850 cast silicone bronze material, threaded ends, manufactured by NIBCO No. T-413-Y-LF or approved equal.
   2. 2-1/2 inches and larger: Class 125, iron body, globe style, renewable seat and disc, spring actuated, lead free, conforming to NSF/ANSI 61 & 372, MSS SP-125, FM approved. For flanged systems - Nibco Model F-910-B-LF, or approved equal. For grooved piping systems - Nibco Model G-920-W-LF, or approved equal.

D. Butterfly Valves (2-1/2 inch and larger): Class 150, ductile iron body conforming to ASTM A-395, fully lugged, drilled body, lever operated, blow out proof type aluminum bronze disc and stem, EPDM seat, suitable for bi-directional dead end service with downstream flange removed, minimum 175 psi bubble tight shut-off, manufactured by NIBCO No. LD-2000, or approved equal. For grooved systems Victaulic Series 608N or NIBCO GD-4765 are acceptable.

2.4 STRAINERS

A. Y type, for pipe sizes 2 inch and less, class 125 rated for working pressure through 200 psig at 200°F, threaded ends, threaded cap, ASTM B62 cast bronze body and cap, 20 mesh stainless steel screen, openings not larger than 1/32 inch, tapped blowout outlet with minimum size of 1/4 inch, similar to NIBCO No. T-413-Y-LF, or approved equal.

B. Y type, for pipe sizes over 2 inch, Class 125, iron body, globe style, renewable seat and disc, spring actuated, lead free, conforming to NSF/ANSI 61 & 372, MSS SP-125, FM approved. For flanged systems - Nibco Model F-910-B-LF, or approved equal. For grooved piping systems - Nibco Model G-920-W-LF, or approved equal.

2.5 VACUUM BREAKERS AND BACKFLOW PREVENTERS

A. Atmospheric Vacuum Breakers: Full line size, manufactured of brass or bronze with full size orifice, dry guide out of the liquid pressure area and disc float closing vent with minimum flow. Manufactured by Watts Regulator, No. 288A Series, or approved equal by Wilkens or Apollo.

B. Pressure Type Vacuum Breaker: Full line size, with full size orifices, manufactured of brass or bronze with double poppit (check valve) stainless steel screen and vent. Manufactured by Watts Regulator, No. LF800M4QT, or approved equal by Wilkens or Apollo.

C. Reduced Pressure Backflow Preventer: Size as indicated on Drawings, manufactured of bronze, rated for 175 psi, and shall include strainer, gate or ball valves based on size, pressure differential relief valve, check valves, test cocks, and relief vent and funnel drain.
   1. Unit shall meet the requirements of ASSE 1013, and AWWA, University of Southern California tested and approved.
   2. Manufactured by Watts Regulator No. 919QT for sizes 2" and less, and No. 957 for sizes over 2-inch, or approved equal by Wilkens or Apollo.
D. Vacuum Relief Valve: 3/4 inch bronze with high temperature resisting disc, and disc guide located out of water.
   1. Tested up to 200 psi and 250°F and shall be open on a vacuum of not more than 1/2 inch of mercury.
   2. Manufactured by Watts Regulator No. N36g, or approved equal by Wilkens or Apollo.

E. Pressure Type High hazard, anti-siphon, anti-spill, vacuum breaker designed for indoor applications, featuring bronze body, one-piece modular check valve and float assembly, stainless steel springs, bronze quarter turn ball valves at inlet and discharge, University of Southern California tested and approved. Manufactured by Watts No. LF800M4QT, or approved equal by Wilkens or Apollo.

F. Dual Check Valve: Tested and certified to meet ANSI/ASSE Standard 1024, testable, cast bronze body, silicone discs, stainless steel springs, manufactured by Watts Series LF7, or approved equal.

2.6 AIR RELIEF VENTS

A. Float operated, constructed of cast iron with stainless steel float and trim and isolating valve:
   1. 1/2 inch, rated at 300 psi at 150°F.
   2. Vents shall be designed to eliminate air from the system automatically without permitting the passage of water.
   3. Minimum 3/4 inch system connection (inlet), minimum 1/2 inch drain connection (outlet), 1/4 inch drilled, tapped and plugged test connection.
   4. Manufactured by Clark-Reliance, Model No. 6-V, or approved equal.

B. For sizes under 2” (Point of Use at Equipment Connections): Automatic in operation, adjustable, renewable stainless steel seat, bronze body, adjustable from 25-75 psi outlet pressure, with stainless steel strainer screen, with gauge tappings, manufactured by Watts No. U5B, or approved equal.

2.7 P-TRAP SEAL PROTECTION

A. Provide ASSE 1072 compliant Rectorseal Floor Drain Trap Sealer (Sure Seal) in all floor drains and floor sinks where electronic trap primers are not indicated on the drawings.

2.8 THERMOSTATIC MIXING VALVES

A. Provide rough bronze construction with a flow range of 1/2 gpm (minimum) through 4.5 gpm at 5 psi pressure loss with integral true service spring loaded check stops (rubber type duck bill check valves are not allowed) and dual stainless steel strainers on inlets, temperature adjustment range 60°F to 140°F, ASSE 1017/1070 compliant, outlet temperature set at 110°F at Sinks and 105°F at the Lavatories in Restrooms, rough chrome or brass finish on valve body. Provide mixing valve in recessed stainless steel cabinet with lockable door where wall mounted fixtures occur. Check stops shall allow water to be shutoff to mixing valve for cartridge maintenance, Manufactured by Symmons 7-225-B-CK-MS-X-T, or approved equal by Powers or Bradley.
2.9 GROUT


B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 CONNECTION

A. Install unions downstream of all threaded valves and in all locations that supply serviceable equipment.

B. Screwed Joints: Make joint with clean, full cut standard pipe threads. Ream after cutting and threading. Use heavy duty Teflon sealing compound or Teflon tape as threaded seal. Sealing compound shall be AGA and NSF certified, non-toxic, non-drying, anti-seize, and classified by UL.

C. Use anti-seize compound on all bolts for flanges.

D. Grooved joints shall be installed in accordance with the manufacturer’s latest published installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gaskets shall be of an elastomer grade suitable for the intended service, and shall be molded and produced by the coupling manufacturer. The grooved coupling manufacturer’s factory trained representative shall provide on-site training for contractor’s field personnel in the use of grooving tools and installation of grooved joint products. The representative shall periodically visit the jobsite and review contractor is following best recommended practices in grooved product installation. (A distributor’s representative is not considered qualified to conduct the training or jobsite visit(s).

E. Press type pipe joints shall be made in accordance with manufacturer’s installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fittings alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the manufacturer’s approved tool.

3.2 INSTALLATION

A. For buried water service, clamp water pipe at fittings with 3/4 inch rods and properly anchor and support.

B. Provide in-line strainer upstream of trap primers. Supply line to trap primers shall be taken off top of domestic cold water main, per manufacturer’s recommendations.

C. Provide a pressure gauge on each side of balancing valves on domestic hot water return loops.
D. Provide backflow preventer certification documentation prior to final acceptance of system.

E. No pulled tees (T-drill) are allowed.

F. Directly downstream from the water heater a thermowell shall be provided for a temperature sensor which will be provided by Division 23 DDC. The temperature sensor shall send an alarm signal to the DDC when the system temperature decreases lower than 130 degrees F.

G. Directly downstream from the hot water return circulation pump a thermowell shall be provided for a temperature sensor which will be provided by Division 23 DDC. The temperature sensor shall control the on/off function of the pump. The pump shall cut on when the temperature decreases to 130 degrees F. The pump shall cut off when the system temperature reaches 140 degrees F. There shall be an override (timer) by the DDC system which will cut off the pump during nighttime hours from 10pm to 4am, unless there is a demand on the system.

H. On the domestic cold water supply to the building a thermowell shall be provided to receive a pressure sensor by Division 23 DDC. The pressure sensor shall alarm when the building pressure drops below a pressure setting. Refer to plumbing drawings for location of the sensor.

3.3 DRAINAGE

A. Install water piping systems with uniform horizontal grade of 1/8 inch per 10 feet, minimum, to low points to provide complete drainage of the system. Where constant pitch cannot be maintained for long runs, establish intermediate low points and rise to new level. Grade branches to drain to mains or risers. Unless otherwise indicated, terminate low points of risers with drain valve piped to nearest hub or floor drain.

3.4 IDENTIFICATION

A. Identify system components. Comply with requirements in Section 22-0553.4, Identification for Plumbing Piping and Equipment, for identification materials and installation.

B. Label pressure piping with system operating pressure.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Piping Inspections:
   1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
   2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
      a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
      b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

C. Piping Tests:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and for corrective action required.

D. Domestic water piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
   a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
   b. Fill and isolate system according to either of the following:
      1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
      2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
   c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
   d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
B. Prepare and submit reports of purging and disinfecting activities.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

END OF SECTION
SECTION 22 1119
DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes requirements for furnishing and installation of plumbing specialties including the following:
   1. Pressure and temperature taps.
   2. Automatic air vents.
   3. Pressure gauges.
   4. Thermometers.
B. Section 22 1116 - Domestic Water Piping Systems.

1.2 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Field quality-control test reports.
C. Operation and maintenance data.

1.3 QUALITY ASSURANCE
A. NSF Compliance:
   2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Pressure and Temperature Tap: Subject to compliance with requirements, provide products by Peterson Engineering Company, or Sisco.
B. Automatic Air Vents: Subject to compliance with requirements provide cast iron body with stainless steel seat and float as manufactured by one of the following:
   1. Apco.
   2. Armstrong.
3. Clark.
4. ITT Bell & Gosset.
5. Taco.

2.2 PRESSURE AND TEMPERATURE TAPS

A. Location: Provide pressure and temperature taps where indicated on plumbing drawings and details.

B. Taps: Provide ½ inch solid brass fittings which will receive either a pressure or temperature probe with valve core of Nordel and fitted with a color coded cap and gasket. Furnish “pete’s Plug” as manufactured by Peterson Engineering Company, or “Sisco P/T Plug” as manufactured by Sisco, No. 710, rated at 275°F and 1000 psig. Provide long stem type for insulated pipe.

C. Instruments: Provide two No. 500 “Pete’s Plug” pressure gauge adapters with four gauges and probes, and four 5 inch stem pocket thermometers. Two thermometers for domestic hot water systems when applicable. “Pete’s plugs” to match insulation thickness.

2.3 WATER SYSTEM AIR VENTS

A. Furnish and install cast iron body fixed pivot ball automatic float-type air vents at high points of all hydronic systems and where shown on Drawings.

1. Cast iron vent body with stainless steel float, and stainless steel seat, valve and lever.
2. Rate vent for a minimum 125 psi, 400°F.

B. Extend 1/2-inch copper discharge drain to nearest floor or hub drain.

C. Ball Valve: Place between air vent and piping system.

1. 600 pound w.o.g., full port two-piece ball valve with stainless steel ball, reinforced seat, blowout proof stainless steel stem and lever handle, similar to Nibco T-585-70-66LF.

2.4 GAUGES AND THERMOMETERS:

A. General. Provide gauges and thermometers for monitoring plumbing systems as shown on the drawings and specified herein.

B. Gauges. Gauges shall be Ashcroft, Trerice, Weksler, Moeller, or U.S. with 4-1/2" dial face, phenol case, stainless steel movement with Grade A phosphor bronze bourdon tube and micrometer-type calibration adjustment screw. Accuracy shall be 1/2 of 1% of full scale. Provide a Crane No. 222H or needle valve with snubbers at the pumps. Provide liquid filled gauges at pumps. Gradation shall be one pound or less.

C. Thermometers. Thermometers shall be Weksler, Marshall Town or Ashcroft with 5" dial, all stainless steel construction bi-metal type with accuracy of +/- 1% of scale range. Minimum of 2-1/2" straight or angle form stem as best suited for reading. Stem length shall be sized to provide most accurate reading for pipe diameter.
D. Thermometer Wells. Thermometer wells shall be brass or stainless steel with pressure and temperature ratings suitable for their application. Wells for insulated piping shall have a 2-1/2" lagging protrusion. Locate thermometer wells so the sensing bulb will give a true and correct reading. Install thermometer so as not to cause undue restriction in small piping. Where wells are located in pipelines 1-1/2" and smaller, provide a section of pipe of such diameter that the net area of the pipeline will not be reduced by the thermometer well. All wells shall be filled with silicon and complete with caps and chains.

E. Range and Gradations. Gauges and thermometers shall be selected to give range and gradations best suited for quantities to be measured. Generally, gauges and thermometers shall be selected so that normal operating pressures and temperatures are not more than 2/3 nor less than 1/2 of the range; scale division shall be 1°F. Typical ranges for domestic cold water and shall be 0° to 100°F and for domestic hot water shall be 30°F to 240°F.

F. Gauge Locations. Provide pressure gauges at the following locations:

1. Suction side of each pump (except sump pumps and sewage ejectors).
2. Discharge side of each pump (except sump pumps and sewage ejectors).
3. At the main domestic service entry.
4. At the top of the main domestic water risers.

G. Thermometer Locations. Provide thermometers and thermometer wells at the following locations:

1. On each hot water circulating loop return line from the building (locate near circulating pump).
2. On each incoming cold water supply to each domestic water heater.
3. On the outlet hot water from the domestic water heater.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Section 22 0500, Common Work Results for Plumbing, for piping joining materials, joint construction, and basic installation requirements.

B. Install hydronic specialty items as shown on Drawings and in accordance with manufacturer’s installation requirements.

C. Provide automatic air vents at all high points in systems. For air vents above ceilings and concealed areas, provide copper vent tubing to nearest hub or floor drain.

D. For strainers, provide valve connection piped to floor drain at all pumps. On strainers that are not piped to drain, provide valved connection with hose adapter and cap.

E. Provide valved manual air vent where indicated on Drawings. Install pipe plug in valve.

END OF SECTION
SECTION 22 1316
SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes requirements for furnishing and installing sanitary waste, soil and grease waste system piping and associated vent piping within buildings and underground laterals within 5 feet of building.

1.2 RELATED WORK
A. Section 22 0500 - Common Work Results for Plumbing.
B. Section 22 0553 - Identification for Plumbing Piping and Equipment.
C. Section 22 0529 - Hangers and Supports for Plumbing and Equipment.

1.3 PERFORMANCE REQUIREMENTS
A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:

1.4 SUBMITTALS
A. Field quality-control inspection and test reports.

1.5 QUALITY ASSURANCE
A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Above Grade Piping, excluding crawl space:

1. Service weight cast iron no-hub soil pipe and DWV pattern fittings. The cast iron soil pipe and fittings shall be manufactured to ASTM A888, ASTM A74 and CISPI 301 (including Annex A). Cast iron soil pipe shall be listed with an ANSI Accredited Testing Agency for quality assurance, and include CISPI Trademark or NSF Trademark stamped or imprinted on the pipe. Manufactured by Charlotte, Tyler or AB & I.

2. Heavy duty shielded stainless steel couplings and tightening devices, ASTM C564 rubber sleeve.

3. 4-band no-hub couplings for pipe sizes 4 inches and less. 6-band no-hub couplings for pipe sizes over 4 inches.

4. Couplings manufactured by Anaco "Husky" SD4000, Ideal Tridon HD or Clamp-All 125.

B. Piping through Wall Sleeves: Provide section of ductile iron piping, as detailed, in wall penetrations.

C. The p-trap for the floor drains receiving condensate shall be schedule 40 PVC with solvent cement joints, the remaining portion of the condensate drainage system shall be as specified in paragraph 2.01B & C herein.

2.2 VENT PIPE AND FITTINGS

A. Vent pipe, fittings, joints and couplings shall be same as specified for the gravity sanitary sewer system as specified herein.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Basic piping installation requirements are specified in Section 22 0500, Common Work Results for Plumbing.

B. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Section 22 0500, Common Work Results for Plumbing.

C. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Wall penetration systems are specified in Section 22 0500, Common Work Results for Plumbing.

D. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings." Install PVC piping system per manufacturer's recommendations.
E. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drainpipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

F. Vent Connections: Make vent connections to vent stacks with inverted wye fittings. Extend full-size vents through roof to at least 6 inches above roof.

G. Flashing: Provide flashing as recommended by roofing material manufacturer and detailed by Architect/Engineer.

H. Cleanouts:
   1. Install cleanouts the same size as the soil waste lines in which the cleanouts are placed. No cleanout should be larger than 4 inches in diameter.
   2. Where cleanouts occur in pipe chases, bring cleanouts through walls and install covers. Where cleanouts occur in floor slabs, set flush.
   3. Provide cleanouts where soil lines change every direction, every 50 feet on long runs, at end of each continuous waste line, and at the base of each riser.

I. Floor Drains: Locate floor drains 1/2 inch below finish floor elevation unless shown otherwise.

J. Slope sanitary waste piping at a uniform slope of 1/8" per foot for pipes sizes 3-inch and larger and 1/4" per foot for pipe sizes less than 3-inch. Slope vent piping at a uniform 1/8" per foot slope with the high point at the roof penetration, sloping back down toward the plumbing fixture. Refer to the plumbing code.

K. Provide joint restraints on cast iron piping for pipe sizes over 4" and in changes in pipe diameter by two pipe sizes or more, and indicated in IPC Section 308, and conforming to CISPI 301-09. Joint restraints shall be Holdrite #117, or approved equal, or as shown on the Plumbing drawings.

3.2 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Section 22 0500, Common Work Results for Plumbing.

   1. Gasketed Joints: Make with rubber gasket matching class of pipe and fittings.
   2. Hubless Joints: Make with rubber gasket and sleeve or clamp.

C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

D. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.
3.3 VALVE INSTALLATION

A. Shutoff Valves: Install shutoff valve on each sewage pump discharge.
   1. Use gate or full-port ball valve for piping NPS 2 and smaller.
   2. Use gate valve for piping NPS 2-1/2 and larger.

B. Check Valves: Install swing check valve, downstream from shutoff valve, on each submersible pump discharge.

3.4 HANGER AND SUPPORT INSTALLATION

A. Seismic-restraint devices are specified in Section 22 0548, Vibration Isolation for Plumbing Piping and Equipment.

B. Pipe hangers and supports are specified in Section 22 0529, Hangers and Supports for Plumbing Piping and Equipment. Install the following:
   1. Vertical Piping: MSS Type 8 or Type 42, clamps.
   2. Individual, Straight, Horizontal Piping Runs: According to the following:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
   3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Install supports according to Section 22 0529, Hangers and Supports for Plumbing Piping and Equipment.

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2: 60 inches with 3/8 inch rod.
   2. NPS 3: 60 inches with 1/2 inch rod.
   3. NPS 4 and NPS 5: 60 inches with 5/8 inch rod.
   4. NPS 6: 60 inches with 3/4 inch rod.
   5. Spacing for 10 foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

G. Install supports for vertical cast-iron soil piping every 15 feet.

H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4: 84 inches with 3/8 inch rod.
   2. NPS 1-1/2: 108 inches with 3/8 inch rod.
   3. NPS 2: 10 feet with 3/8 inch rod.
4. NPS 2-1/2: 11 feet with 1/2 inch rod.
5. NPS 3: 12 feet with 1/2 inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8 inch rod.
7. NPS 6: 12 feet with 3/4 inch rod.

I. Install supports for vertical steel piping every 15 feet.

J. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

K. Support PVC piping with maximum hanger spacing per manufacturer's recommendations

3.5 CONNECTIONS

A. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

B. Where PVC pipe connects to cast iron piping use transition type no-hub coupling. Provide heavy duty shield type transition coupling specifically designed for cast iron to PVC pipe material changes, similar to Heavy Duty Shielded Transition couplings by Anaco Husky or approved equal, conforming to ASTM C1460, ASTM C564 and meets CSA B602. Coupling shall have 304 stainless steel clamp, screw and shield with ASTM C564 gasket material.

3.6 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Test pipe before backfilling and connecting to sewers by maintaining not less than 10 feet of hydrostatic head for 4 hours without a leak.
2. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
3. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction.

1. After all sections of soil, waste, and vent piping are installed, but before fixtures are connected, test system by plugging all outlets and filling vertical sections with water to maintain not less than 10 feet of hydrostatic head for 4 hours without any drop in water level for all sections of piping. Provide wyes as required to facilitate plugging.
2. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
3. Prepare reports for tests and required corrective action.
3.7 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION
SECTION 22 1319
SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes the following sanitary drainage piping specialties:
   1. Drains.
   2. Cleanouts.

1.2 RELATED WORK
A. Section 22 0500 – Common Work Results for Plumbing.
B. Section 22 1316 – Sanitary Waste and Vent Piping.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories.

1.4 QUALITY ASSURANCE
A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following, except special custom trench drains which shall be only the specified manufacturer:
   1. Wade
   3. Josam
2.2 DRAINS

A. Design of drains is based on model numbers manufactured by Wade, unless otherwise indicated. Subject to compliance with requirements, provide named product or comparable product by one of the listed acceptable manufacturers:

1. Floor Drains (FD-1): Wade No. 1100-G6-1, cast iron floor drain with flashing collar, seepage flange, nickel bronze 6 inch square adjustable strainer with square holes.
2. Floor Sink (FS-1): Wade No. 9150-1-15-24-26-48, cast iron 12 inch square floor sink with 10 inch sump, acid resistant porcelain interior, aluminum dome interior strainer, 1/2 nickel bronze grate, with clamping device.

2.3 CLEANOUTS

A. Location:

1. Provide drainage lines with properly specified cleanouts.
2. Locate cleanouts in runs not more than 90 feet on centers or as required by local authority having jurisdiction.
3. Provide cleanouts at the base of each soil or waste stack and wherever necessary to make accessible all parts of the drainage soil or waste systems, whether or not indicated on drawings.
4. Extend cleanouts within chases to near wall and provide wall access cover compatible with wall construction.
5. Provide cleanouts of required size, with flashing flange where installed with membrane waterproofing.

B. Finished and Unfinished Walls. Wade No. 8303-85-VP-75, duracoated, cast iron cleanout with cast bronze plug and square polished stainless steel wall cleanout access panel with secured smooth cover and frame with anchor lugs.

C. Floor Cleanouts. Wade No. 6000-1-75, painted cast iron floor cleanout with anchor flange, adjustable top, secured scoriated cover, adjustable threaded bronze plug, and satin finish nickel bronze cover.

D. Exposed Piping. Wade No. 8550-75, cast iron calk ferrule and cast bronze plug with ½” NPT test port with raised head plug and internal threading for test plug use.

E. Outside Area. Wade No. 6000-12-75, painted cast iron floor cleanout with anchor flange, adjustable top, secured scoriated cover, adjustable threaded bronze plug, cast flush in a 16 inch x 16 inch x 6 inch thick concrete pad in nonsurfaced areas.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Section 22 0500, Common Work Results for Plumbing, for piping joining materials, joint construction, and basic installation requirements.
B. Install cleanouts in above ground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
   a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
   b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
   c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

E. Install deep-seal traps on floor drains and other waste outlets, if indicated.

F. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.

G. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

H. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

3.2 CONNECTIONS

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

B. Install piping adjacent to equipment to allow service and maintenance.
3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each grease interceptor.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 22 0553.4, Identification for Plumbing Piping and Equipment.

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION
SECTION 22 4000
PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Sinks.
   2. Fixture Carriers.
   3. Lab Sink Faucets
   4. Emergency Shower Units
   5. Emergency Eyewash Units

B. Related Sections include the following:
   1. Section 22 1116 - Domestic Water Piping.
   2. Section 22 0500 - Common Work Results for Plumbing.

1.2 DEFINITIONS


B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

C. FRP: Fiberglass-reinforced plastic.

D. PMMA: Polymethyl methacrylate (acrylic) plastic.

E. PVC: Polyvinyl chloride plastic.


1.3 SUBMITTALS

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

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Operation and maintenance data.
1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.


C. Regulatory Requirements:
   2. Comply with requirements in Texas Senate Bill 587 for requirements about minimum water conservation performance requirements.

D. NSF Standard: Comply with NSF 61, “Drinking Water System Components—Health Effects,” for fixture materials that will be in contact with potable water.

E. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

F. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
   1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
   2. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
   5. Vitreous-China Fixtures: ASME A112.19.2M.

G. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
   1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
   2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
   5. Hose-Connection Vacuum Breakers: ASSE 1011.

H. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
   2. Brass and Copper Supplies: ASME A112.18.1.

I. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Disposers: ASSE 1008 and UL 430.
6. Off-Floor Fixture Supports: ASME A112.6.1M.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers.

B. Lavatory & Sink Faucets:

1. Chicago Faucets.
2. Symmons Industries, Inc.
4. T&S Brass.
5. Speakman.
6. Sloan
7. Delta Commercial.

C. Stainless Steel Sinks:

1. Just Manufacturing Co.
2. Elkay Manufacturing Co.
3. Moen, Inc.
4. Griffin
5. Advance Tabco

D. Sink Trim (Supplies, Traps, Strainers):

1. McGuire
2. Elkay Manufacturing Co.
3. Chicago Faucets.
5. Kohler Co.

E. Emergency Showers:

1. Haws.
2. Guardian.
4. Acorn Safety

F. Plumbing Fixture Carriers

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

2.2 SINKS

A. Single Compartment Sink (SK-1):

1. Bowl: Elkay ELUHAD211555 23-1/2" x 18-1/4" x 5-3/8" deep, ADA compliant, self-rimming, single compartment sink, with undercoating, 18-gage, Type 302 stainless steel.
2. Faucet: Kohler “Purist” 24982 or approved equal single-hole deck mounted chrome plated faucet, with swing gooseneck spout with pull down spray head and magnetic dock, single handle lever operation, 1.5 gpm flow control device, quarter turn cartridges, vandal resistant and ADA compliant
3. Supplies: McGuire No. LF2165-LK supply, escutcheon, 3/8" x 12" flexible tube riser and loose key control angle stop, all with chrome finish. Compression connections are not allowed.
4. Trap: McGuire No. 8912, 1-1/2" adjustable cast brass P-trap with tubing drain to wall, ground swivel joint, cleanout plug and cast brass escutcheon, all with chrome finish.
6. Insulation Kit: Same as specified for Lavatory "L-1".
7. Provide ASSE 1070 compliant thermostatic mixing valve with maximum outlet temperature of 120 degrees F, as specified in spec. section 21 1116.

2.3 LAB SINKS

A. Specified in Specification Section 12 3553.13.

1. Bowl: Refer to Architectural drawings.
2. Faucet: Provided by Lab Casework Supplier and specified in Division 12.
3. Supplies: McGuire No. LF2165-LK supply, escutcheon, 3/8" x 12" flexible tube riser and loose key control angle stop, all with chrome finish. Compression connections are not allowed.
4. P-Trap: Refer to specification section 22 6653.
5. Emergency Eyewash Unit (Where indicated on the architectural drawings).
6. Provide sink strainer to insert into each cast epoxy resin sink and stainless steel sinks (not stainless steel hand wash sinks) specified in spec section 12 3553.13. Strainer fit into sink drain outlet and shall be removable, class 27 stainless steel mesh, similar to LabScientific Supplies and Equipment Model No. DP40C and DP60C (provide specific model for size of drain outlet), or approved equal. Coordinate model with sinks specified in section 12 3553.13 and the location shown on the “A800” drawings.

7. Where shown on plumbing plans with hot water connections: Provide ASSE 1070 compliant thermostatic mixing valve with maximum outlet temperature of 120 degrees F, as specified in spec. section 22 1116.

2.4 ROUGH-IN BOX

A. Rough-in Box (RB-1): Furnish and install hook-up box, constructed of 20 gauge steel, recessed, painted to match wall, with 1/2” chrome plated angle valve, manufactured by Guy Gray No. BIM875, with 5-micron cartridge type filter and housing to be installed between angle valve and equipment. Mount top of box at 15” above finished floor.

2.5 WATER HAMMER ARRESTORS

A. Provide hydraulic shock absorbers in cold and hot water supply lines to each individual plumbing fixture or battery of fixtures, and at each automatic, solenoid-operated or quick-closing valve serving mechanical, kitchen or laundry equipment. Shock arrestors shall be of seamless type "K” copper body construction or type 304 stainless steel body with stainless steel bellows, nitrogen and helium gas pre-charged. Shock arrestor shall be certified to ASSE 1010-2004 Standard and listed with IAPMO, completely sealed and operating free of casing. Size all units according to water hammer arresters standard PDI-WH-201. The shock arrestor shall have a lifetime warranty and shall be designed to provide continuous protection without maintenance allowing the shock arrestor to be installed without an access panel. Manufactured by Sioux Chief “Hydra-Rester”, Mi-Fab, Jay R. Smith and FNW.

2.6 EMERGENCY SHOWERS

A. (ES-1) – Refer to Division 12 specifications. Provide Water supplies to shower.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers’ written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
   1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
   2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
   3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.
D. Install wall-mounting fixtures with tubular waste piping attached to supports.

E. Install fixtures level and plumb according to roughing-in drawings.

F. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

G. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

H. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment, unless sensor operated. Install other actuators in locations that are easy for people with disabilities to reach.

I. Install toilet seats on water closets.

J. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

K. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.

L. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

M. Install traps on fixture outlets:
   1. Exception: Omit trap on fixtures with integral traps.
   2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

N. Install escutcheons at piping wall and ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Section 22 0500.4, Common Work Results for Plumbing.

O. Refer to Architectural drawings for fixture mounting heights.

P. Provide an ASSE 1070 compliant thermostatic mixing valve on the domestic hot water and cold water supply piping serving break room sinks, hand wash sinks and lavatories, and where shown on the drawings.

3.2 CONNECTIONS

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

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Ground equipment according to Division 26 requirements.
D. The installation of rough-ins and carriers of water closets shall be inspected by Owner and/or Engineer prior to coverup. The supports/carriers for water closets shall be securely anchored to the floor and shall be heavy weight type carriers, rated to support a minimum of 500 lbs.

E. For sinks not indicated to be provided by Division 22, provide the same supply stops as specified for sinks herein. Compression connections are not allowed.

F. Install shock arrestors on pipe headers for fixture groups in locations shown on plumbing riser diagrams and as recommended by the manufacturer. Domestic water supplies to single plumbing fixtures shall be provided with shock arrestors. The use of only air chambers as shock protection is not allowed.

3.3 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.4 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION
SECTION 22 6119

COMPRESSED AIR SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Provide compressed air system for laboratory use. For the systems rough-in and make final connection of piping system to lab outlets, fume hoods, overhead service carriers, service fittings, etc. where indicated on the Plumbing floor plans and Lab Casework Drawings. Provide and install all piping, fittings, valves, air compressor assemblies, etc. for a complete operational laboratory compressed air system. This Section includes requirements for compressed air systems and the following accessories:

1. Air compressors.
2. Air dryers.
3. Filters.
4. Regulators.
5. Valves.
6. Pipe and fittings.

1.2 RELATED SECTIONS

A. Section 22 0500 - Common Work Results for Plumbing.
B. Section 22 0526 - Pipe and Fittings.
C. Section 22 0548 - Vibration Isolation for Plumbing Piping and Equipment.
D. Section 22 0553 - Identification for Plumbing Piping and Equipment.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design compressed-air equipment mounting, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Delegated-Design Submittal: For compressed-air equipment mounting indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation:

1. Detail fabrication and assembly of supports.
2. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.

C. Field quality-control reports.

D. Operation and maintenance data.

1.5 MAINTENANCE MATERIALS

A. Provide maintenance materials as required and listed in approved O&M including but not limited to the following:

1. (6) Air compressor inlet filter elements.
2. (2) Air compressor outlet filter elements.
3. (2) Air dryer inlet filter elements.
4. (2) Air dryer after filter elements.
5. (4) Purge mufflers for air dryers.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the compressed-air equipment testing indicated, that is an NRTL and that is acceptable to authorities having jurisdiction.

1. Qualify testing personnel according to ASSE 6020 for inspectors and ASSE 6030 for verifiers.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. ASME Compliance: Fabricate and label receivers to comply with ASME Boiler and Pressure Vessel Code.

D. Comply with NFPA 99, "Health Care Facilities," for compressed-air equipment and accessories where designated for laboratory air systems and medical compressed air systems.

1.7 DELIVERY STORAGE AND HANDLING

A. Deliver pumping systems, controllers, and accessories in factory-fabricated water-resistant wrapping.

B. Handle pumping systems, controllers, and accessories carefully to avoid damage to materials, components, enclosure, and finish.

C. Store pumping systems, controllers, and accessories in a clean, dry space and protect from the weather.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ohio Medical
2. Powerex.
3. Amico.
5. Domnick Hunter.
6. Airtech.
7. Arrow.
10. Ingersall Rand
11. Champion
12. Nano
13. Patton’s Medical

2.2 LAB AIR COMPRESSOR SYSTEM (LAC-1)

A. General: Provide and install a factory supplied lab air compressor package which includes open air compressor skid with duplex air compressors, with integral electronic controller, pre-filters, afterfilters, twin air dryers, air receiver and filter/regulator assembly and master control panel, all factory assembled and wired. The master control panel shall control the air compressor compressors, to stage on and off based on system demand (use) as demand increases and decreases. Of the multiple compressors, 1 compressor will serve as a backup, but will be wired to run and alternate as all the other compressors, but the controller shall be designed to allow all compressors to run at a time. Starting of compressors shall be staggered with a 10 second start delay between compressors. Warranty shall be for 30 months from date of shipment or 24 months from date of start-up, whichever occurs first, which includes parts and labor. Manufactured by Ohio Medical, Beacon Medaes or Powerex.

B. Air Compressors: The air compressors shall be multi-core single stage, air cooled, oil free, scroll type air compressors. An air cooled after cooler to be provided for each air compressor, sized to provide an approach temperature of 20°F. Each unit shall be constructed of copper tubing with metal headers and shall be mounted integral to the compressor unit. Each compressor shall have a high efficiency TEFC motor with Class F insulation with motor starter.
C. Air Compressor Control Panel: The electrical control panel shall be UL Listed in a NEMA 12 cabinet with on/off control of all of the compressor units. Controls shall start/stop compressors individually to conserve energy. The controls shall include main power disconnect, individual lockable motor disconnect switches with motor protection fuses, magnetic motor starter with three phase overload protection, redundant 120 volt circuit transformers with fused primary and secondary pressure transmitters and programmable logic controller to automatically sequencing of the compressors. HOA selector switches, hour meters, lag alarm, indicating lights and silence and rest buttons shall be provided. Controller shall be capable of sequencing-in core units, and controller shall monitor as a minimum, unit on/off, run hours, and emergency shutdown. A single 460 volt 3 phase 60 hertz power connection shall be field provided from master control panel to the compressor module. The circuits from the master control panel to the air dryers shall be factory provided (on same skid as dryers).

D. Air Dryers: Provide twin type tower adsorption/regenerative desiccant type dryers. The dryers will be able to deliver air with a constant dewpoint for lab air use. Each dryer shall be fully automatic with a 0.01 micron cartridge type coalescing pre-filter and a 1 micron particulate cartridge type after-filter. Complete with power on/off switch and light, ASME relief valve, with factory installed gauges on inlet and outlet, factory installed activated alumina desiccant, membrane condensate drain, lower shuttle valve, desiccant cartridges, upper shuttle valve, ASME coded pressure vessel, rated for 150 psi, NEMA 4 panel with solid state controls, and moisture indicator, dewpoint monitor, and auto on demand air purge saving control.

E. Receiver: Fabricated vertical ASME coded carbon steel vessel, conforming to requirement set forth in ASME, galvanized or internal epoxy coated for a minimum pressure of 150 psi the laboratory air compressor system. The lab air compressor system shall have a 80 gallon capacity, complete with safety valve, electronic automatic drain, sight glass, 0-150 psi pressure gauge with inspection manhole.

F. Filtration/Pressure Regulator Assembly: The filtration system shall consist of two activated carbon filters. All filters shall have a differential pressure gauge with change indicator. Downstream of final filters shall be dual line pressure regulator assembly consisting of two pressure regulators with pressure gauges, inlet and outlet ball valves and pressure relief valve. All filters and pressure regulators shall be arranged so that isolation of one filter or regulator will not affect the operation of the second filter or regulator. Refer to floor plans for pressure setting of the pressure regulators. The pressure regulators shall be set to discharge 55 psig.

G. Package shall be provided with a BACnet Communication remote monitoring to the Building Automation System (BAS) system for the following:

   1. Compressor Status (indicating operation if any compressor is on).
   2. Compressor Failure Alarm (alarm upon any compressor failure).
   3. High Humidity Alarm

2.3 AUTOMATIC DRAINS FOR AFTERCOOLERS

A. Mechanically activated automatic type condensate drain. Body coated for corrosion resistant. Shell constructed of steel and seals shall be Viton. Rated for maximum working pressure to 200 psi. Automatic drain consisting of pilot valve, piston, float, magnet and valve stem. Drains shall be routed to floor drain. Manufactured by Hankison.
2.4 REGULATORS
   A. Compressed Air System Serving the Lab Areas: Zinc die cast body, diaphragm-operated, direct-acting, spring-load, manual pressure setting adjustment, Nitrile seals, complete with 0-160 psi pressure gauge, rated for a maximum of 300 psi inlet pressure, gauge ports, adjustable pressure range of 0 to 180 psig, manufactured by Wilkerson Model R30-XX-G00, or approved equal.

2.5 SAFETY VALVES
   A. ASME coded, pressure vessels constructions, National Board-certified, labeled, and factory seal, constructed of bronze body with poppet safety valve, for compressed air service. 130 psi setting.

2.6 PIPE AND FITTINGS
   A. Compressed Air System Serving the Lab Areas (CA & LA): Hard drawn Type “L” copper pipe, conforming to ASTM B819, factory prepared for oxygen service, as specified herein. Fittings shall be seamless wrought copper, socket joint, ANSI B16.22. Joints shall be brazed, using nitrogen purge, as specified herein. Brazing alloy shall be NFPA 99C compliant, conforming to BS EN 10044CP. Unions shall be wrought copper with metal to metal seats.

2.7 GAUGES
   A. Bourbon tube type, with stainless steel spring, suspended movement, 316 stainless steel bourbon tube, with minimum 2-1/2 inch dial, shatterproof glass window with stainless steel case, 1/4 inch NPT brass socket connection, 1 percent full scale accuracy and shall be made in accordance with ASME 40.1 grade 1A, scale range 0-160 psi, Figure intervals at 20 psi, and minor divisions at 2 psi increments, manufactured by Trerice No. 700 series, or approved equal.

2.8 UNIONS
   A. Provide Class 150, 300-pound water-oil-gas service wrought solder joint fitting, such as Nibco 633/733 union C x C, or approved equal, ANSI B16.22. Flange joints larger than 2 inches shall be brass. Provide dielectric isolating unions or connections between metallic piping of dissimilar metal.

2.9 VALVES
   A. 3-piece bronze ball valve with extended copper tube ends, 316 stainless ball and stem, 600 WOG, full port, in-line repairable, RPTFE seats, blow out proof stem, manufactured by Milwaukee No. BA350S-TE or approved equal.

2.10 ACCESSORIES
   A. For Air Compressor System Serving the Lab Areas: Provide a weatherproof outside air intake filter/muffler for installation on the system intake.
B. Provide the following accessories for each compressor:

1. Isolation valves.
2. Pressure relief valves.
3. Inlet and discharge check valves.
4. Regulators.
5. Pressure reducing valves.
7. Pressure switches.
10. Strainers.
11. Shock arrestors.
12. Flexible connection.
14. Gauges and other required accessories for a complete and fully functional and operational system.

2.11 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 22 0513, Common Motor Requirements for Plumbing Equipment and as specified herein.

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

2.12 PIPE SUPPORTS

A. Refer to Section 22 0529, Hangers and Supports for Plumbing Piping and Equipment.

2.13 FLEXIBLE CONNECTORS

A. Refer to Section 22 0548, Vibration Isolation for Plumbing Piping and Equipment.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean compressed-air equipment, accessories, and components that have not been cleaned for oxygen service and capped or that are furnished unsuitable for laboratory air applications, according to CGA G-4.1, "Cleaning Equipment for Oxygen Service." Tape is not an acceptable sealing method.

B. Ream pipe and tube ends full pipe bore. Remove burrs. Bevel plain end ferrous pipe. Remove scale dirt on inside and outside before assembly. Prepare piping connections to equipment with flanges or unions.
3.2 INSTALLATION

A. Compressed Air Equipment Installation:

1. Install compressed-air equipment, except wall-mounting equipment, on concrete bases. Install units anchored to substrate in locations indicated. Maintain manufacturers' recommended clearances. Orient equipment so controls and devices are accessible for servicing. Install according to ASSE 6010 and NFPA 99.
   a. Anchor equipment to concrete bases according to manufacturer's written instructions and seismic criteria applicable to Project.
      1) For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
      2) Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
      3) Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Route piping in orderly manner and maintain gradient.

C. Install piping to conserve building space and not interfere with use of space.

D. Group piping whenever practical at common elevations.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Where pipe support members are welded to structural building framing, scrape, brush clean, weld, and apply one coat of zinc rich primer.

G. Protect piping systems from entry of foreign materials by temporary caps, completing sections of the work, and isolating parts of completed system.

H. Contractor is responsible for complying with all state and local regulations.

3.3 CONNECTIONS

A. Comply with requirements for water-supply piping specified in Section 22 1116, Domestic Water Piping Systems. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements for drain piping specified in Section 22 1316, Sanitary Waste and Vent Piping. Drawings indicate general arrangement of piping, fittings, and specialties.

C. Install piping adjacent to equipment to allow service and maintenance.

D. Connect compressed air piping to compressed air equipment, accessories, and specialties with shutoff valve and union or flanged connection.
3.4 IDENTIFICATION

A. Identify compressed-air equipment system components. Comply with requirements for identification specified in Section 22 0553, Identification for Plumbing Piping and Equipment and NFPA 99. The compressed air system shall have piping, fittings and valves identified as lab air use, and lab equipment use.

3.5 FIELD QUALITY CONTROL FOR COMPRESSED AIR SYSTEMS

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections:

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. Compressed Air Equipment Testing Coordination: Perform tests, inspections, verifications, and certification of compressed-air equipment concurrently with tests, inspections, and certification of compressed air piping and laboratory gas piping systems.

2. Preparation: For the Lab Air System perform compressed air equipment tests according to requirements in NFPA 99 for the following:
   a. Air quality purity test.
   b. System operation test.

3. Equipment Verification: Comply with requirements in ASSE 6020, ASSE 6030, and NFPA 99 for verification of compressed air equipment.

4. Replace damaged and malfunctioning controls and equipment.

5. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
   a. Inspections performed.
   b. Procedures, materials, and gases used.
   c. Test methods used.
   d. Results of tests.

E. Components will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

G. Follow NFPA 99 guidelines and requirements for the compressed lab air system. All the compressed lab air systems does not need to be third party certified, but shall comply with the requirements and guidelines of NFPA 99 as it shown and specified.

H. Installers for the compressed lab air system shall be certified in medical gas piping systems installations.
3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

   1. Complete installation and startup checks according to manufacturer’s written instructions.
   2. Check for lubricating oil in lubricated-type equipment.
   3. Check belt drives for proper tension.
   4. Verify that air-compressor inlet filters and piping are clear.
   5. Check for equipment vibration-control supports and flexible pipe connectors and verify that equipment is properly attached to substrate.
   6. Check safety valves for correct settings. Ensure that settings are higher than air-compressor discharge pressure but not higher than rating of system components.
   7. Drain receiver tanks.
   8. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   9. Test and adjust controls and safeties.

END OF SECTION
SECTION 226219 - LABORATORY VACUUM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. The Conditions of the Contract and applicable requirements of Division 1, General Requirements, and Section 22 05 00, Common Work Results for Plumbing, govern this Section.

1.2 DESCRIPTION OF WORK
   A. Work Included: Provide laboratory vacuum piping as specified, scheduled, and indicated. Rough-in and make final connection of laboratory vacuum piping to overhead service carriers, counter turrets, wall turrets, fume hoods, biological safety cabinets, etc. Provide and install all pipe, fittings, valves, etc. associated with the vacuum system for a totally complete operational system.
   B. Types: The vacuum system required for the project include, but are not limited to, the following:
      1. Valves.
      2. Pipe and Fittings.

1.3 RELATED SECTIONS
   A. Section 22 05 00 - Common Work Results for Plumbing.
   B. Section 22 05 26 - Pipe and Pipe Fittings.
   C. Section 22 05 48 - Vibration Isolation for Plumbing Piping and Equipment.
   D. Section 22 05 53 - Identification for Plumbing Piping and Equipment.

1.4 GENERAL REQUIREMENTS
   A. Provide new equipment, approved, free from flaws and blemishes.
   B. Provide approved plumbing fittings for equipment connections.
   C. Equipment shall be product of one manufacturer. Fittings and valve connections of same type shall be product of one manufacturer.
   D. Protect equipment against use and damage during construction.

1.5 SUBMITTALS
   A. Shop drawing submittals shall include, but not be limited to, the following:
   B. Cut sheets on the following:
1. Pipe and Fittings.
2. Valves.
3. Additional information as required in Section 22 05 00, Common Work Results for Plumbing.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Store pipe, fittings and valves in a clean, dry space and protect from the weather.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Pipe shall be hard drawn Type “L” copper, conforming to ASTM B88, factory prepared for oxygen service, as specified herein. Fittings shall be seamless wrought copper, socket joint, ANSI B16.22. Joints shall be brazed, Nitrogen purge during brazing is not required. Unions shall be wrought copper with metal to metal seats. Brazing alloy shall be NFPA 99C compliant, conforming to BS EN 10044CP.

2.2 GAUGES

A. Bourbon tube type, with stainless steel spring, suspended movement, 316 stainless steel bourbon tube, with minimum 2-1/2 inch dial, shatterproof gas window with stainless steel case, 1/4 inch NPT brass socket connection, 1 percent full scale accuracy and shall be made in accordance with ASME 40.1 grade 1A, scale range in inches of mercury, manufactured by Trerice No. 700 series, or approved equal.

2.3 UNIONS

A. Provide Class 150, 300-pound water-oil-gas service wrought solder joint fitting, such as Nibco 633/733 union C x C, or approved equal, ANSI B16.22. Flange joints larger than 2 inch shall be brass. Provide dielectric isolating unions or connections between metallic piping of dissimilar metal.

2.4 VALVES

A. Ball Valves. Three piece, 600 psi WOG, cast brass body, RPTFE seats, full port, blowout proof stems, quarter turn handle with stainless steel ball and stem and extended female tube ends for brazing connection, in-line repairable, manufactured by Milwaukee BA-350-TE, or approved equal.

2.5 PIPE SUPPORTS

A. Refer to Section 22 05 29, Hangers and Supports for Plumbing Piping and Equipment.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Components: The supplier shall certify that the system as provided meets all the requirements of the plumbing code. Installation of pipe and fittings shall be per NFPA 99, as related to Laboratories.

B. Testing, Start-up and Certification: After checkout, testing and startup, the system supplier shall provide the Owner with a notarized letter certifying that the system is properly sized and installed and that the system is in proper working order and complies with all applicable requirements of NFPA, as related to Laboratories.

3.2 PRESSURE TESTING

A. Test piping and prove free of leaks at completion prior to beginning, cleaning, and purging.

B. Perform service leak tests as specified and per applicable requirements of state and local codes, ANSI/ASME B31.1 Code for Power Piping, on piping systems.

C. Before acceptance of the work, pressure test completed systems in the presence of the Owner and authorities having jurisdiction.

D. Test the piping systems per the applicable governing codes and the requirements specified. Pressure test the piping system as outlined in NFPA 99, with an initial pressure test set for 15 psi. Then a standing pressure test set at 24 inches Hg for 24 hours without leak. Provide equipment and materials and make test connections required to execute tests. Make tests before piping surfaces are concealed.

E. Contractor shall furnish the compressed air or nitrogen to be used for test purposes.

F. Other than standard piping, caps and valves, use only commercially manufactured expandable elastomer plugs for sealing off piping for test purposes. The safe test pressure rating of plug used shall be not less than two times the actual test pressure being applied. Do not use expandable elastomer plugs for piping which could develop sufficient reactive force to cause damage to a structure, other piping or cause moving of thrust or anchor provisions in case of blow-out.

G. Remove components from piping systems during testing whenever the component may sustain damage due to test pressure or test media. After completion of the test, reinstall the component and reapply test at the component pressure rating.

H. Check system components such as valves for functional operational under system test pressure. If the test pressure exceeds the valve manufacturer's rating for seat test, the termination block valves shall remain open during the test and the system shall be blocked by other means.

I. Prepare and maintain test records of piping systems tests. Records shall show Contractor personnel responsibilities, dates, test gauge identification numbers, ambient temperature, pressure ranges, rates of pressure drop and leakage rates. Notify Architect/Engineer and Owner prior to test for witnessing. Two record copies of acceptance tests shall be delivered to the Architect/Engineer after acceptance.

J. Architect/Engineer shall approve test procedures before proceeding with the work.
K. Upon successful completion of the system pressure testing, the system will be dried, sealed and left ready for connection of equipment by others.

3.3 FLUSHING, CLEANING, PURGING

A. The piping system shall be thoroughly and completely purged with instrument grade compressed air or nitrogen upon completion of work. Erection, for piping, tubing and fittings not factory pre-cleaned, prior to shall be thoroughly cleansed of all grease, oil and other combustible materials by washing in a hot solution of sodium carbonate or trisodium phosphate mixed in equal proportions of one pound to three gallons of water. Scrubbing and continuous agitation of the parts shall be employed where necessary to remove all deposits and ensure complete cleansing. After washing all materials, shall be rinsed thoroughly in clean hot water. After rinsing, great care must be exercised in the storage and handling of all materials and in the condition of tools used in cutting and reaming to prevent oil or grease being introduced into the tubing. Where such contamination is known to have occurred, the materials affected must be rewashed and rinsed.

B. Where threaded connections are required at connection points to equipment or lab turrets and/or outlets, suitable adapters shall be provided with threaded connections. A thin past of litharge and glycerin shall be applied to the external threads only.

C. After erection of pipe and tubing, but prior to installation of the service outlet valves, each system shall be blown clear of moisture and foreign matter by means of dry nitrogen.

3.4 PIPELINE IDENTIFICATION LABELS AND BANDS

A. Refer to Specification Section 22 05 53, Identification for Plumbing Piping and Equipment.

3.5 INSTALLATION

A. General: Installer shall examine conditions under which the system is 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.

B. Installation: The system shall be installed as shown on the drawings and in accordance with manufacturer’s written instructions and detailed field installation drawings.

C. Install capped drip leg 6 inches long at the end of the main piping runs with a valved drain piped to the nearest floor drain.

3.6 CONNECTIONS

A. Brazed Connections.

3.7 BRAZED JOINTS

A. All brazed joints shall be made with materials specified. The amount of brazing alloy used per connection shall be the minimum required to assure a leak tight joint. Brazed joints are to be field fabricated.
B. Make all cuts square. Remove all burrs and slivers prior to cleaning.

C. Clean surfaces to be joined prior to brazing. Remove all oil, grease and heavy oxide. Clean pipe surfaces at least 1/2 inch beyond the full engaged length into the fitting. Care should be exercised to remove surface film but not metal. Clean socket of fitting with the same precautions observed.

D. Brazing under nitrogen purge is not required. Follow the instructions of the manufacturer for joining procedures.

E. Assemble joint making sure the tube is firmly against the end of the fitting socket.

F. Strictly follow manufacturer's procedures.

3.8 DIELECTRIC CONNECTIONS

A. Dielectric connections shall be used when joining piping of dissimilar metals such as copper to steel, cast iron, or malleable iron.

B. Connections shall be made with dielectric screwed unions or with flanges having non-conducting gasket, washers and bolt inserts.

C. Dielectric unions to meet requirements of ANSI B16.39. Dielectric flange fittings to meet requirements of ANSI B16.24 for bronze and ANSI B16.42 for iron.

3.9 ROUTE AND GRADES

A. Route piping approximately as indicated in orderly manner and maintain proper grades. Install to conserve headroom and interfere as little as possible with use of space. Avoid routing piping at elevations capable of causing occupant hazards. Run exposed piping parallel to walls. Group piping whenever practical at common elevations.

B. Piping shall be installed as nearly as possible parallel with or at right angles to the building walls. Install pipe straight and plumb. Springing or forcing piping into place will not be permitted unless specifically called for. Install piping in such a manner as to prevent strain on equipment connections.

C. Provide clearance for installation and maintenance of valves, drains, unions and other piping specialties such as pressure gauges.

D. Install plugged drip pockets at low points.

E. Pipe take-offs from piping shall be off the top of the pipe, unless otherwise noted on drawings.

F. At the base of the vacuum system pipe risers, install valve and threaded caps for draining of system.

3.10 START-UP SERVICES

A. A manufacturer’s factory trained representative shall be available on the job-site to check the installation and start-up of package. The manufacturer’s representative shall be responsible for training the Owner’s Representative on the operation and proper maintenance of the unit.
B. After system has been in operation for 90 days, the Contractor shall check all seals and replace any which are defective.

C. Contractor shall provide to Owner a written sequence of restarting vacuum pumping package upon event of vacuum pumping equipment being taken off-line.

3.11 IDENTIFICATION

A. Refer to Section 22 05 00, Common Work Results for Plumbing, for applicable painting, nameplates, and labeling requirements.

END OF SECTION 226219
SECTION 22 6653

LABORATORY CHEMICAL WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section Includes:
   1. Lab waste traps.
   2. Lab waste and vent pipe and fittings.

1.2 RELATED WORK

A. Section 22 0500 – Common Work Results for Plumbing.
B. Section 22 1316 – Sanitary Waste and Vent Piping

1.3 SYSTEM DESCRIPTION

A. Provide all labor, materials, equipment, tools, and services to perform all operations required in connection with or properly incidental to the construction of complete lab waste and vent system as indicated on Drawings, and as required for a complete and functional system.

1.4 PERFORMANCE REQUIREMENTS

A. Piping Pressure Rating: 10 feet head of water.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Shop Drawings: For leak-detection system. Include plans, elevations, sections, details, and attachments to other work.
   1. Cut sheets of lab waste/vent pipe, fittings, and other required accessories clearly indicating all features, options, materials, and dimensions.
   2. Wiring Diagrams: For power, signal, and control wiring.
C. Field quality-control test reports.
D. Operation and Maintenance Data: For chemical-waste specialties and neutralization tanks and leak-detection systems to include in emergency, operation, and maintenance manuals.
1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 70, "National Electrical Code."

1.7 DELIVERY STORAGE AND HANDLING

A. Deliver lab waste/vent piping system components in factory-fabricated water-resistant wrapping.

B. Handle lab waste/vent piping system components carefully to avoid damage to material components, enclosure, and finish.

C. Store lab waste/vent piping system components in a clean, dry space and protect from the weather.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements provide specified products by one of the following:

1. Lab Waste Pipe and Fittings:
   a. Charlotte.
   b. Spears.
   c. GF Harvel.

2.2 LAB WASTE TRAPS

A. All trap material shall be chemically resistant 3" deep seal Universal traps with 1-1/2" female inlet, constructed of flame retardant polypropylene. Unit shall have mechanical joints and all adapters and couplings required for a complete installation between sink outlet and drainage system. Manufactured by Enfield Model W501 or approved equal.

B. Joints: The joining of the cup sink tailpieces and other sink outlets and strainers to the acid waste piping system shall be the responsibility of the Mechanical Contractor.

2.3 LAB WASTE AND VENT PIPE AND FITTINGS

A. Utilize materials as indicated and described herein.

1. CPVC Pipe and Fittings: Schedule 40 CPVC Type IV Grade 1, ASTM cell class 23447, listed by ULC S102.2, meeting the maximum flame spread rating of 25 and a maximum smoke development rating of 50 when tested in accordance with ASTM E-84 (UL 723). Fittings shall be standard DWV pattern and joints shall be solvent cement socket type conforming to ASTM D1784 and ASTM F2618.
2.4 HANGERS AND SUPPORTS

A. Horizontal Piping: Support fill horizontal piping on clevis type hangers.

B. Vertical/Riser Piping: Support all vertical/riser piping using riser clamps with 1/4 inch thick solid neoprene or Buna-N rubber.

C. Wall Chase Piping: Support all wall chase piping using the wall/chase support system as specified in Section 22 0529, Hangers and Supports for Plumbing Piping and Equipment.

D. Sleeves: Size sleeves per manufacturer’s recommendations for CPVC piping.

2.5 JOINING MATERIALS

A. Couplings: Assemblies with combination of clamps, gaskets, sleeves, and threaded or flanged parts; compatible with piping and system liquid; and made by piping manufacturer for joining system piping.

B. Adapters and Transition Fittings: Assemblies with combination of clamps, couplings, adapters, gaskets, and threaded or flanged parts; compatible with piping and system liquid; and made for joining different piping materials.

C. Flanges: Assemblies of companion flanges and gaskets complying with ASME B16.21 and compatible with system liquid, and bolts and nuts.

D. Solvent Cement for Joining CPVC Piping shall be according to the pipe manufacturer’s written guidelines and recommendations. Generally, fabricate pipe as follows:

1. Cut pipe with pipe manufacturer recommended tools.
2. Remove burrs and bevel ends of pipe.
3. Clean and dry pipe and fittings.
4. Dry pipe cut pipe and fittings.
5. Apply primer if recommended by pipe manufacturer. If primer is used, primer shall be specifically designed for CPVC pipe joining. Apply with manufacturer’s recommended applicator.
6. Apply ASTM F493 solvent cement specifically designed for CPVC pipe with manufacturer’s recommended applicator.
7. Join pipe and fitting.
8. Pipe joint shall be cured as recommended by the manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install piping, fittings and accessories in strict accordance with the manufacturer’s written installation instructions and applicable codes. Buried underground installations shall conform to ASTM D2321, ASTM D2774 and ASTM F1668. Pipe installation under carton form construction shall be as specified in Section 22 1316.

B. Pipe Slope: Slope waste and vent piping as specified in Section 22 1316, Sanitary Waste and Vent Piping.
C. Damaged Piping: Remove damaged piping and replace at the Contractor’s expense.

D. Buried Piping: Excavation and backfill for buried piping shall be as specified in Section 22 0500, Common Work Results for Plumbing, and Section 22 1316, Sanitary Waste and Vent Piping, and per the piping system manufacturer’s requirements. Bedding backfilling shall comply with ASTM D2321.

E. Waterstops: Pipe passing through building walls or slabs shall pass through a pipe sleeve of pipe diameter recommended by the watertight assembly manufacturer. The annular space between the pipe and sleeve shall be sealed using segmented annular seals as specified in Section 22 0500, Common Work Results for Plumbing.

F. Hangers and Supports: The entire piping system and related hangers and supports shall be installed such that the piping system is properly aligned and free of stress.

G. Vertical stacks shall be supported at each floor using riser clamps. The lowest riser support shall be located below the lowest coupling/hub on the stack and shall restrict sideways as well as downward motion.

H. Horizontal piping shall be supported using Clevis type hangers with maximum hanger spacing as follows, per the manufacturer’s recommendations:

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>CPVC Pipe Support Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1/2”</td>
<td>5’ - 0”</td>
</tr>
<tr>
<td>2”</td>
<td>5’ - 0”</td>
</tr>
<tr>
<td>3”</td>
<td>6’ - 0”</td>
</tr>
<tr>
<td>4”</td>
<td>6’ - 6”</td>
</tr>
<tr>
<td>6”</td>
<td>7’ - 0”</td>
</tr>
</tbody>
</table>

I. Locate hangers at each offset, bend or fitting and where more than two couplings are installed between hangers on glass systems. Support 1 foot of each joint upstream and downstream of joint. Follow pipe manufacturer’s recommendations and guidelines.

J. Install cleanouts in horizontal lines at a maximum of 50 foot intervals.

3.2 LABELING AND IDENTIFICATION

A. Comply with requirements in Section 22 0553, Identification for Plumbing Piping and Equipment, for labeling of equipment and piping.

1. Use detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.
3.3 FIELD QUALITY CONTROL

A. Inspect interior of sewerage piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place and again at completion of Project.

1. Defects requiring correction include the following:
   a. Alignment: Less than full diameter of inside of pipe is visible between inspection points.
   b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
   c. Crushed, broken, cracked, or otherwise damaged piping.
   d. Hydrostatic Tests for Drainage Piping:
      1) Allowable leakage is a maximum of 50 gal./inch of nominal pipe size per mile of pipe, during 24-hour period.
      2) Close openings in system and fill with water.
      3) Purge air and refill with water.
      4) Disconnect water supply.
      5) Test and inspect joints for leaks.
   e. Air Tests for Drainage Piping: Comply with UNI-B-6.

2. Leaks and loss in test pressure constitute defects that must be repaired.

3. Submit separate reports for each test.

B. Replace leaking sewerage piping using new materials, and repeat testing until leakage is within allowances specified.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections:

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

E. Chemical-waste piping will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.4 CLEANING

A. Use procedures prescribed by authorities having jurisdiction or, if not prescribed, use procedures described below:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.

2. Clean piping by flushing with potable water.
SECTION 22 6719.16
REVERSE OSMOSIS (RO) WATER EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes reverse-osmosis-water equipment and piping system.

1.2 DESCRIPTION
A. Provide and install all piping system components, and any miscellaneous items for a complete working RO water system. Refer to the plumbing drawings and details.

1.3 RELATED WORK
A. Section 22 0500 – Common Work Results for Plumbing.
B. Section 22 0529 – Hangers and Supports for Plumbing Piping and Equipment.
C. Section 22 0553 – Identification for Plumbing Piping and Equipment.

1.4 SUBMITTALS
A. Product Data: For each type of pipe and fitting indicated.
B. Field quality-control test reports.
C. Shop drawing submittals include but are not limited to the following:
   1. Cut sheets on all equipment showing features, characteristics, and capacities.
   2. Manufacturer’s recommended installation instructions for system.
   3. Water analysis results.
   4. Floor plan layout showing equipment in floor space available.

1.5 QUALITY ASSURANCE
A. Piping materials shall bear label, stamp, or other markings of specified testing laboratory.

1.6 DELIVERY STORAGE AND HANDLING
A. Components and accessories in factory-fabricated water-resistant wrapping.
B. Handle equipment and accessories carefully to avoid damage to material components, enclosure, and finish.

C. Store equipment and accessories in a clean, dry space and protect from the weather.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the listed manufacturers.

B. Pipe, Fittings, Valves:

1. Orion.
2. George Fischer.
3. Enfield.
4. Simtech.
5. Plast-O-matic.
6. Asahi.
7. Harrington Industrial Plastics

C. Flow Meters:

1. George Fischer.
2. King Instrument.
4. Blue White Industries

2.2 BACK PRESSURE REGULATING VALVE

A. Designed to maintain constant pressure in line upstream of valve.

B. Adjustable pressure range of 7-60 psi, polyurethane construction, FPM O-rings, PTFE diaphragm, socket union ends, manufactured by George Fischer No. V586, or approved equal.

2.3 PIPE AND FITTINGS

A. Not in Return Air Plenums: Provide and install Group 1 Class 2, nucleated homopolymer polypropylene piping with a pressure rating of 150 psi at 70°F (SDR 11), meeting ASTM D4101-86, and DIN 8077, and ASTM D-2837 and shall be capped at each end from factory. Fittings shall be same material, thickness and pressure rating as pipe, with socket fused, joints, manufactured by George Fischer "Beta" or Simtech "Puretech AP", or approved equal.

B. In Return Air Plenums: Provide natural virgin unpigmented PVDF pipe and fittings with socket heat fused joints shall be used, conforming to ASTM D-3222 rated for minimum 150 psi at 68°F., meeting 25/50 flame and smoke spread requirements of ASTM E84 and UL910.
2.4 VALVES

A. Ball Valves: Provide and install true union style ball valves, factory tested to 150 psi at 73°F, same material as pipe with socket ends, blow-out proof stem, Teflon seats, Viton seals, fully compatible with specified pipe, manufactured by George Fischer Model 346, or approved equal.

B. Check Valves: Provide and install true union style ball check valves, polypropylene construction with socket ends, Viton O-ring and seating ring, 150 psi pressure rating at 68°F, manufactured by George Fischer No. 561, or approved equal.

C. Diaphragm Valves: Manual weir type, true union ends, FPM O-ring with PTFE diaphragm, position indicator, stainless steel bolts, 150 psi pressure rating at 68°F, manufactured by George Fischer No. 514, or approved equal.

D. RO water piping system valves within return air plenums shall be of PVDF construction, as specified for the piping.

2.5 PIPE CLAMPS

A. Support horizontal piping with padded clevis type hangers or trapeze hanger where grouped with other piping.

B. Where installed on trapeze hangers, directly to walls or within walls, provide and install pipe clamps constructed of U.V. stabilized polypropylene or nylon, to allow free axial pipe movement during expansion and contraction of pipe system.

C. Support spacing shall be to the pipe manufacturer's recommendations for the design temperature of the system, capable of mounting to steel framing channels or wall, manufactured by Enfield Cobra or Ryan Herco Clic.

2.6 FLOW CONTROL

A. Provide and install flow control valve, factory set at 1/2 gpm with polypropylene body and EPDM seal, will maintain constant flow with pressure changes 15 psi to 120 psi, manufactured by Plast-O-matic, or approved equal. To be provided upstream of lab sink RO faucets only.

2.7 ROTAMETERS

A. Provide and install flow meter on the RO Water return loops where shown on drawings with 150 psi pressure rating, polysulphone tube, polypropylene or PVDF socket ends, Viton O-rings, Teflon or PVDF float, 3% accuracy of full scale.

B. RM-1 - Flow range: 1.3 -13.0 gpm flow range. Manufactured by Georg Fischer No. SK 20 or approved equal.

C. Refer to piping diagram for location of rotameters.
2.8 PRESSURE REDUCING VALVES
   A. Provide pressure reducing valve consisting of natural polypropylene body, socket ends, adjustable downstream pressure, manufactured by Plast-O-Matic Series “PRE”, or approved equal.

2.9 PRESSURE RETAINING VALVE (BACKPRESSURE REGULATING VALVE)
   A. Provide pressure reducing valve consisting of natural polypropylene body, socket ends, keeps the system working pressure constant, to balance out pressure pulsations, manufactured by George Fischer No. V86

2.10 PIPING MATERIALS
   A. Transition Fittings: Couplings, flanges, or other manufactured fittings, same size as, with pressure rating at least equal to and ends compatible with piping to be joined.

PART 3 - EXECUTION

3.1 SANITIZATION
   A. Water treatment vendor shall be responsible to sanitize entire RO Water loop distribution system with Minncare cold sterilant.

3.2 PIPING APPLICATIONS
   A. Transition and special fittings with pressure ratings at least equal to and of material same as, or compatible with, piping may be used in applications in this article, unless otherwise indicated.

3.3 PIPING INSTALLATION
   A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of reverse-osmosis-water piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
   B. Refer to Section 22 0500, Common Work Results for Plumbing, for general piping installation requirements.

3.4 JOINT CONSTRUCTION
   A. Refer to Section 22 0500, Common Work Results for Plumbing, for basic piping joint construction. Where specific joint construction is not indicated, follow piping manufacturer's written instructions.
   B. Piping Joints: Make heat-fusion joints similar to procedure in ASTM D 2657 for polyolefin piping joints.
C. Joint dissimilar pipe materials with transition fittings compatible with pipe materials being joined.

3.5 VALVE INSTALLATION

A. Install sectional valves close to mains on each branch and riser serving equipment.

B. Install shutoff valve on each supply to equipment.

3.6 FIELD QUALITY CONTROL

A. Test new piping and parts of existing piping that have been altered, extended, or repaired, for leaks and defects.
   1. Schedule tests and their inspections by authorities having jurisdiction, with at least 24 hours' advance notice.
   2. Do not cover or put into service before inspection and approval.
   3. Test completed piping according to authorities having jurisdiction. If authorities having jurisdiction do not have published procedures, perform tests as follows:

B. Hydrostatic Tests: Test piping at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than 150 psig.
   1. Replace leaking joints with new materials and retest until no leaks exist.
   2. Submit separate reports for each test.

3.7 CLEANING

A. Use procedures prescribed by Owner or, if not prescribed, use procedures described below:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.

B. Clean piping by flushing with system reverse osmosis water.

3.8 DEMONSTRATION AND TRAINING

A. The supplier/installer of the water treating system shall provide for owners/operators a quantity of six Instruction Manuals covering all major components of the system, with a parts breakdown of each, along with a priced list of recommended spare parts and consumables.

B. The owner/operator personnel shall be provided with a 4-hour session of training as soon as can be mutually arranged after equipment commissioning and a follow-up 4-hour training session within the next 90 days.

END OF SECTION
SECTION 23 0010
MECHANICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Except as modified in this Section, General Conditions, Special Conditions, applicable provisions of Division 01, General Requirements, and other provisions and requirements of the contract documents apply to work of Division 23.

B. Applicable provisions of this Section apply to all Sections of Division 23 HVAC.

C. Contract drawings are diagrammatic only and do not give fully dimensioned locations of various elements of work. Determine exact locations from field measurements, and provide coordination drawings.

D. All work in these Sections shall be installed by craftsmen skilled in their trade.

1.2 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. Furnish: The term "furnish" is used to mean supply and deliver to the project site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. Install: The term "install" is used to describe operations at project site including the actual unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

H. Provide: The term "provide" means to furnish and install, complete and ready for the intended use.
1.3 CODE REQUIREMENTS AND PERMITS

A. Perform work in accordance with applicable statutes, ordinances, codes, and regulations of governmental authorities having jurisdiction.

B. Resolve any code violation discovered in contract documents with the Engineer prior to award of the contract. After award of the contract, make any correction or addition necessary for compliance with applicable codes at no additional cost to Owner.

C. Obtain and pay for all permits and inspections.

D. The following building codes are applicable to this project.
   1. 2018 International Mechanical Code
   2. 2018 International Building Code
   4. 2016 ASHRAE 90.1

1.4 REFERENCES

A. Materials which are specified by reference to Federal Specifications; ASTM, ASME, ANSI, AWWA Specifications, Federal Standards or other standard specifications must comply with latest editions except where specified otherwise in individual Sections, revisions, amendments, or supplements in effect on date bids are received.

B. Requirements in reference specifications and standards are minimums for all equipment, materials and work. In instances where capacities, size or other features of equipment, devices, or materials exceed these minimums, meet listed or shown capacities.

1.5 SUBMITTALS

A. Equipment and Materials submittals must show sufficient data to indicate complete compliance with contract documents as follows:
   1. Proper sizes and capacities.
   2. That the item will fit in the available space in a manner that will allow proper service.
   3. Construction methods, materials, and finishes.
   4. Provide a statement with each submittal verifying that all of the materials and equipment submitted complies with the specifications, indicate all exceptions and deviations to the specifications.

B. Material and Equipment List: Within 30 days after award of the contract and before orders are placed or shop drawings are submitted, submit a list of equipment and principal materials specified. Give names of manufacturers, catalog and model numbers, and such other supplementary information as necessary for identification.

C. Material and Equipment Shop Drawings: Submit all detailed shop drawings, descriptive literature, physical data, and performance data for review for items of equipment and for principal materials proposed for installation. HVAC controls may be submitted separately provided the controls submittal is complete and coordinated with all other applicable trades. Include identifying symbols and equipment numbers used in plans and specifications, with reference to specification paragraphs, and drawing numbers of all equipment and material submitted.
D. Final Submittal: In addition to number of copies of shop drawings and other data required for review submittals, maintain a separate file of final approved copies of such material. Deliver approved copies in a hard-back binder for the Owner's use. Incorporate changes and revisions made throughout construction period. Delivery of approved copies is a condition of final acceptance for the project.

E. Contractor's Check: Shop drawings will be submitted only by the Contractor. Indicate by signed stamp that the drawings have been checked, that the work shown on the drawings is in accordance with contract requirements and that dimensions and relationship with work of other trades have been checked. If drawings are submitted for approval that have not been checked and signed by the Contractor, they will be returned for checking before being considered by the Architect/Engineer.

1.6 COORDINATION DRAWINGS

A. Prior to starting work, the Contractor shall provide coordination drawings for all areas of the building. The Contractor shall submit the coordination drawing for confirmation of the coordination process. The Contractor is responsible for all trade confirmation.

B. CAD. Provide 1/4 inch scale coordination drawings.
   1. Drawings shall show all equipment, ductwork, cable trays, fire protection system, coil pull spaces, chilled water, heating water and condensate piping and trap, electrical conduit, electrical and control panels, etc. installed in mechanical room to verify space allocation and coordination of trades.
   2. Provide plan and elevation views detailing installation.
   3. Drawings shall include 1/4 inch scale drawing of each mechanical room. Drawing shall show coil pull spaces and coordination of all ductwork, all chilled water, heating water and condensate piping and trap, electrical conduit, electrical and control panels, etc. installed in mechanical room. Provide plan and elevation views detailing installation.
   4. Contractor may not proceed with construction of MEP systems until trade coordination process has been demonstrated to be completed by the Contractor to the Architect, Engineer and Owner.

1.7 INTERFERENCE DRAWINGS

A. Interference drawings are drawings that indicate conflict between the various systems and other components of the building such as beams, columns, walls, etc. They shall be drawn to scale and shall include plans, elevations, sections and other details as required to clearly define the interference and to indicate the contractor's proposed solution.

B. They shall be submitted for approval whenever job measurements and an analysis of the drawings and specifications by the contractor indicate that the various systems cannot be installed without significant deviation from the intent of the contract. When such interference is encountered, work shall cease in the general area of the conflict until a resolution to the question has been approved.

1.8 GUARANTEE

A. Guarantee work for one year from the date of final acceptance of the project. During that period make good any faults or imperfections that may have arisen due to defects or omissions in materials or workmanship.
1.9 SERVICE
   A. Perform service work required during the guarantee period including lubrication of bearings. Perform manufacturer’s recommended monthly service and provide Owner with written report. Cleaning of air filters and pipe strainers is not included.

1.10 RESOLUTION OF CONFLICTS
   A. Where conflicts may exist between and/or within the drawings and/or specifications, the higher quality, greater quantity, more restrictive, and/or more expensive requirement shall be required and shall be the basis of Contractor pricing. The Contractor shall notify the A/E for resolution of the issue prior to executing the work in question.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT
   A. Furnish new and unused materials, pipes, pipe fittings, and equipment of domestic manufacture, where available. Where two or more units of same type or class of equipment are required, provide units of a single manufacturer.

2.2 ACCEPTABLE MANUFACTURERS
   A. Acceptable manufacturers are listed in individual Sections of Division 23. Where two or more units of same type or class of equipment are required, provide units of a single manufacturer.

   B. Manufacturers’ names and catalog numbers specified under Sections of Division 23 are used to establish standards of design, performance, quality and serviceability and not to limit competition.

   C. Equipment of similar design, equal to that specified, manufactured by a manufacturer named in the acceptable manufacturers' list will be acceptable on approval.

   D. Substitutions:
      1. If the Contractor desires to substitute a material or method as an equal to the specified item, he shall request permission from the Architect/Engineer, in writing, and shall include such literature, samples, etc., deemed necessary to establish the equal quality of his proposal.
      2. If the Architect/Engineer deems it necessary in order to establish the equality between two or more products, he may require laboratory testing at the Contractor's expense in order to obtain information upon which to base a decision.
      3. The Architect/Engineer will not give approval to material salesmen or subcontractors, and only in writing to the successful Contractor after the project has been awarded.
      4. For each proposed substitution product, clearly show how the proposed product meets the requirements of the specifications, including performance.
      5. No substitution will be considered unless it is presented in writing within that number of days after Notice to Proceed equal to 15 percent of the contract time.
      6. Proposers of substitute products shall present samples, literature, test and performance data, record of other installations, names of Owners, architects, engineers, contractors and subcontractors as references, statement of current financial condition, and other
technical information applicable to their products, to aid in determining the worth of the substitute product offered in relation to the material and work specified from the standpoint of the Owner's best interest. Substitute materials and products shall be used only if approved in writing by the Architect/Engineer in advance.

7. Approval of substitute materials offered shall not be a basis for contingent extra charges because of changes in other work or related work, such as roughing-in, electrical, structural or architectural, which may result from the substitution.

8. For any Contractor initiated substitutions or changes, Contractor shall be responsible for achieving results equal to or better than the product or design originally specified.

E. Basis of Design: Where a basis of design is indicated (i.e., scheduled products), that product was used for the purposes of established space requirements, structural design for the building, utility connections, etc. If the contractor elects to furnish a product other than the basis of design product (either another named acceptable manufacturer or via substitution) the contractor is responsible for any construction or design costs associated with the non-basis of design product.

2.3 NOISE AND VIBRATION

A. Select equipment to operate with minimum noise and vibration. If objectionable noise or vibration is produced or transmitted to or through the building structure by equipment, piping, ducts or other parts of work, rectify such conditions without cost to the Owner. If the item of equipment is judged to produce objectionable noise or vibration, demonstrate (without cost to the Owner) that equipment performs within designated vibration limits indicated in the specifications, or as specified by manufacturer.

B. Seal all wall and partition penetrations (the penetration opening shall be one inch larger than penetrating member) by ducts and piping by stuffing the annular void with fiberglass insulation and then caulking over fully with a non hardening acoustical caulking applied to both sides of wall or partition.

2.4 AIR FILTERS

A. Turn over to Owner additional sets of spare filters and other spare parts as specified.

2.5 ACCESS DOORS

A. Provide access doors for all walls or ceiling locations as required for access to valves, controls, regulating devices, water arresters, fire dampers, air distribution boxes, and other concealed equipment requiring maintenance adjustment or operation. Coordinate location with General Contractor.

B. Basis-of-Design Product: Design of access doors is based on model numbers manufactured by Milcor unless otherwise indicated. Subject to compliance with requirements, provide named product or approved equal.

1. Non-Fire Rated Doors:
   a. Furnish Milcor non-fire rated doors with 16-gage frames and 14 gage door panels.
   b. Provide continuous concealed hinges and flush screwdriver cam lock.
   c. Use Style M for prime painted steel, and MS for stainless steel.
   d. Use Style DW access door for drywall or gypboard construction.
   e. Use Style CF for suspended drywall ceilings.
f. Use Style K for plastered walls and ceilings.
g. Use Style AP for acoustical plastered ceilings with all galvanized construction.

2. Fire-Rated Access Doors:
   a. Furnish Milcor, UL listed, 1-1/2 hour, “B” label for service access in walls of stairwell, corridors and all other areas where fire-rated construction occurs.
   b. Access doors shall have a 16 gage steel frame and 20 gage insulated sandwich type insulated panel.
   c. Use ATR for fire-rated suspended drywall ceilings.

3. Provide spring-loaded door for automatic closure and exterior key lock for security.

2.6 FLAME SPREAD PROPERTIES OF MATERIALS

A. Materials and adhesives incorporated in this project shall conform to NFPA Standard 255, "Method of Test of Surface Burning Characteristics of Building Materials" and NFPA 90. The classification shall not exceed a flame spread rating of 25 for all materials, adhesives, finishes, etc., specified for each system, and shall not exceed a smoke developed rating of 50.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Cooperation with Other Trades: Cooperation with trades of adjacent, related, or affected materials or operations and of trades performing continuations of work under subsequent contract is considered a part of this work in order to effect timely and accurate placement of work and to bring together in proper and correct sequence the work of such trades.

B. Workmanship: Work must be performed by workmen skilled in their trade.

C. Installation of all equipment and materials must be complete. Installation shall meet requirements of specifications and manufacturer’s recommendations.

D. Electrical Wiring of Motors and Equipment. The Contractor shall note that the electrical design was based upon the mechanical equipment indicated on the mechanical construction documents and specifications. If Contractor proposes any mechanical equipment that requires changes to the electrical design, the required electrical changes shall be made at no cost to the Owner.

3.2 SPACE REQUIREMENTS

A. Consider space limitations imposed by contiguous work, including clearances required for service, in selection and location of equipment and material. Do not provide equipment or material which is not suitable in this respect.

B. The following space allocation and coordination shall be followed, unless otherwise indicated on the construction drawings:
   1. Gravity-fed plumbing and roof drain line shall take priority over all other systems.
   2. Light fixtures and cable tray arrangements shall take priority in spatial layout. In areas with ceilings, other systems shall be routed above the light fixtures, and offset from above cable tray allowing for access and maintenance clearance.
3. Install HVAC ductwork as close to the bottom of structural framing as possible while allowing clearance for installation of insulation wrap. Install ductwork to be accessible from the ceiling plane.

4. Install HVAC chilled/hot water piping in the plane directly below HVAC ductwork unless indicated otherwise on drawings.

5. Install fire sprinkler piping in the plane directly beneath the HVAC chilled/hot water piping. Do not install sprinkler piping directly below equipment requiring maintenance.

6. Install domestic hot and cold water in the plane directly above the light fixtures.

7. Refer to Division 26 for electrical and control wiring requirements.

8. Install piping to permit removal of coils at air handling units and to permit access to all terminal unit components.

3.3 OBSTRUCTIONS

A. The drawings indicate certain information pertaining to surface and subsurface obstructions which has been taken from available drawings. Such information is not guaranteed, however, as to accuracy of location or complete information.

B. Before any cutting or trenching operations are begun, verify with Owner's Representative, utility companies and other interested parties that all available information has been provided. Verify locations given.

C. Should obstruction be encountered, whether shown or not, alter routing of new work, reroute existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing services and structures in a satisfactory and serviceable condition.

D. Assume total responsibility for and repair any damage to existing utilities or construction.

3.4 OPENINGS

A. Framed, cast or masonry openings for ductwork, equipment and piping are specified under other divisions. However, drawings and layout work for exact size and location of all such openings are included under this division.

3.5 ACCESS DOORS

A. Coordinate location of access doors for ease of operation and maintenance of concealed equipment.

3.6 DELIVERY, STORAGE AND HANDLING

A. Adequately protect work, equipment, fixtures and materials from damage during storing, installation, start-up and testing.

B. Cover all equipment stored exposed to elements with waterproof tarps, provide adequate ventilation.

C. At work completion, all work must be clean and in like new condition.
D. Storage of all mechanical equipment, piping materials and ductwork shall be in strict accordance with manufacturers written installation instructions.

E. Provide factory installed pipe caps for all pipes to be installed on the project.

F. Provide covers over all openings in ductwork stored or installed on the project.

3.7 LUBRICATION AND OIL

A. Provide a complete charge of correct lubricant and/or oil for each item of equipment requiring lubrication.

3.8 PAINTING

A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections for Interior Painting and Exterior Painting.

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.9 CUTTING AND PATCHING

A. General: Cut and patch walls, floors, etc., resulting from work or by failure to provide proper openings or recesses in new construction.

B. Methods of cutting: Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Architect/Engineer.
   1. Do not use impact-type equipment except where specifically acceptable to the Architect/Engineer.
   2. Core drill openings in precast concrete slabs for pipes, conduits, outlet boxes, etc., to exact size.

C. Restoration: Restore all openings to "as-new" condition under the appropriate Specification Section for the materials involved.

D. Match remaining surrounding materials and finishes.

E. Masonry: Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry.

F. Provide adequate support during cutting operation to prevent any damage to the masonry occasioned by the operation. All structural members, supports, etc., shall be of the proper size and shape, and shall be installed in a manner acceptable to the Architect/Engineer.

G. Special Note: No cutting, boring, or excavating which will weaken the structure shall be undertaken.
3.10 OPERATING TESTS

A. After all mechanical systems have been completed and put into operation, subject each system to an operating test under design conditions to ensure proper sequence and operation throughout the range of operation witnessed by Owner’s Representative.

B. Prove operations of control systems and all safeties, freezestats and alarms.

C. Make adjustments as required to ensure proper functioning of all systems.

D. Special tests on individual systems are specified under individual Sections.

3.11 OPERATING AND MAINTENANCE INSTRUCTIONS

A. Furnish copies of commercially available standard operation and maintenance data, including operating instructions, maintenance instructions and parts listings. Detailed requirements for these items are as follows:

1. Information required for the preparation of O&M manuals may be furnished in the form of manufacturers’ standard brochures, schematics, and other printed instructions. Clearly distinguish between information which applies to the equipment and information which does not apply. Data shall include as a minimum the following items:
   a. Recommended procedures and frequencies for preventive maintenance; inspection, adjustment, lubrication, cleaning, etc.
   b. Special tools and equipment required for testing and maintenance.
   c. Parts lists reflecting the true manufacturer’s name, part number and nomenclature.
   d. Recommended spares by part number and nomenclature and spare stocking levels.
   e. Integrated mechanical and electrical system schematics and diagrams to permit operation and troubleshooting after acceptance of the system.
   f. Troubleshooting, checkout, repair and replacement procurement procedures.
   g. Operating instructions including start up and shutdown procedures.
   h. Safety considerations including load limits, speed, temperature and pressure.

2. Provide O&M manuals for all HVAC equipment.

3.12 PROJECT RECORD DOCUMENTS

A. Maintain at the job site a separate set of white prints of the contract drawings for the sole purpose of recording the “as-built” changes and diagrams of those portions of work in which actual construction is significantly at variance with the contract drawings.

B. Mark the drawings with a colored pencil.

C. Prepare, as the work progresses and upon completion of work, drawings clearly indicating locations of various lines, valves, ductwork, traps, equipment, and other pertinent items, as installed.

D. At conclusion of project, obtain without cost to Owner, reproducibles of original mechanical drawings and transfer as-built changes to these.

E. Delivery of as-built prints and reproducibles is a condition of final acceptance.
SECTION 23 0020
MECHANICAL DEMOLITION

PART 1 - GENERAL

1.1 WORK INCLUDED
   A. Mechanical demolition for remodeling and work within existing buildings.

1.2 RELATED DOCUMENTS
   A. The requirements of the General Conditions, Supplementary Conditions, Division 01, and Drawings apply to all Work herein.
   B. Requirements of the following Division 23 Sections apply to this section:
      1. Section 23 0010, Mechanical General Provisions

1.3 SCOPE
   A. Existing buildings and their facilities must remain functional while the Work under this Contract is performed. All system shutdowns and outages must be minimized, provided with temporary heating or cooling systems as part of the base bid and coordinated with the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT
   A. Materials and equipment for patching and extending work: as specified in individual Sections.
   B. Provide all materials necessary for work.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. All demolitions or modifications to existing systems shall be coordinated through Owner's Representative. Demolition drawings are based on field observation and existing record documentations. Therefore, the accuracy or exactness of the drawings is not guaranteed. The Contractor shall verify that field measurements and routing arrangements are as shown on Drawings and abandoned infrastructure and equipment serve only abandoned facilities. The Contractor shall be responsible for reporting discrepancies to Engineer before disturbing existing installation.
   B. Beginning of demolition means Contractor accepts existing conditions.
3.2 PREPARATION

A. Disconnect mechanical systems in walls, floors, and ceilings scheduled for removal. Provide temporary piping, ductwork and connections to maintain remaining systems in service during demolition and/or modification. Owner reserve the right up to 24 hours prior to any scheduled event to delay or suspend shutdowns or outages to more convenient times at no additional cost.

B. Existing Mechanical Service: Maintain existing systems not scheduled for demolition in operational condition.

C. Where owner allows existing mechanical systems to be used during demolition and renovation, it is the contractors’ responsibility to protect these systems from debris generated by the work process by means of temporary filters and strainers. In addition, at the completion of the project the contractor must repair/replace any damaged equipment and clean the equipment at no cost to the owner. The contractor is responsible for maintaining water treatment in the same or better condition than before the systems were turned over. The contractor is responsible for any treatment required prior to draining piping to prevent corrosion.

3.3 DEMOLITION AND WORK WITHIN EXISTING BUILDINGS

A. General:
1. During the construction and remodeling, portions of the project shall remain in service. Construction equipment, materials, tools, extension cords, and similar items shall be arranged so as to present minimum hazard or interruption to the occupants of the building. Make every effort to minimize damage to the existing building and the Owner's property. Repair, patch, or replace, as required, any damage that might occur as a result of work at the site. Care shall be taken to minimize interference with the Owner's activities during construction. Cooperate with the Owner and other trades in scheduling and performance of the work.
2. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.
   a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap remaining piping with same or compatible piping material.
   b. Piping to Be Abandoned in Place: Drain piping and cap piping with same or compatible piping material.
   c. Ducts to Be Removed: Remove portion of ducts indicated to be removed and cap remaining ducts with same or compatible ductwork material.
   d. Ducts to Be Abandoned in Place: Cap ducts with same or compatible ductwork material.
   e. Equipment to Be Removed: Disconnect and cap services and remove equipment.
   f. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
   g. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
   h. All piping and ductwork that is not to be reused shall be removed back to the nearest main and capped with similar material.
3. Where piping or ductwork is removed, repair insulation where existing insulation is damaged or where duct/pipe is capped with new products matching existing insulation.
4. Refrigerant: Remove refrigerant from mechanical equipment to be selectively demolished according to 40 CFR 82 and regulations of authorities having jurisdiction.

B. Loss or Damage: The Contractor shall be responsible for loss or damage to the existing facilities caused by him and his workmen, and shall be responsible for repairing or replacing
such loss or damage. The Contractor shall send proper notices, make necessary arrangements, and perform other services required for the care, protection and in-service maintenance of all mechanical services for the new and existing facilities. The Contractor shall erect temporary barricades, with necessary safety devices, as required to protect personnel from injury, removing all such temporary protection upon completion of the work.

C. Operational Continuity: The Contractor shall provide temporary or new services to all existing facilities and utility streams as required to maintain their proper operation when normal services are disrupted as a result of the work being accomplished under this project.

D. Utility Access: Where existing construction is removed to provide working and extension access to existing utilities, Contractor shall remove doors, piping, air conditioning ductwork and equipment, and similar items to provide this access and shall reinstall same upon completion of work in the areas affected.

E. Demolition of Architectural/Structural Elements: Where partitions, wall, floors, or ceiling of existing construction are indicated to be removed and reinstalled, this Contractor shall remove and reinstall, in locations approved by the Architect, all devices required for the operation of the various systems installed in the existing construction.

F. Scheduled Service Outages: Outages of services as required by the new installation will be permitted but only at a time approved by the Owner. The Contractor shall allow the Owner two (2) weeks in order to schedule required outages. The time allowed for outages will not be during normal working hours unless otherwise approved by the Owner. All costs of outages, including overtime charges, and temporary systems shall be included in the contract amount.

G. Pre-Demolition Salvage Survey: The Contractor shall modify, remove, and/or relocate all materials and items so indicated or as required by the installation of new facilities. All removals and/or dismantling shall be conducted in a manner as to produce maximum salvage. Survey the project with the Owner's Representative before demolition begins and determine all materials that the Owner specifically chooses to be salvaged. Pre-establish with the Owner locations where salvaged materials are to be stored. Salvage materials shall remain the property of the Owner, and shall be delivered to such destination as directed by the Owner. Materials and/or items scheduled for relocation and which are damaged during dismantling or reassembly operations shall be repaired and restored to good operative condition. The Contractor may, at his discretion and upon the approval of the Owner, substitute new materials and/or items of like design and quality in lieu of materials and/or items to be relocated.

H. Relocated Equipment: All items that are to be relocated shall be carefully removed in reverse to original assembly or placement and protected until relocated. The Contractor shall clean and repair and provide all new materials, fittings, and appurtenances required to complete the relocations and to restore to good operative order. All relocations shall be performed by workmen skilled in the work and in accordance with standard practice of the trades involved.

I. Damaged Materials/Equipment to be Reused: When items scheduled for relocation are found to be in damaged condition before work has been started on dismantling, the Contractor shall call the attention of the Owner to such items and receive further instructions before removal. Items damaged in repositioning operations are the Contractor's responsibility and shall be repaired or replaced by the Contractor as approved by the Owner, at no additional cost to the Owner.

J. Termination of Utility Services: Service lines and piping to items to be removed, salvaged, or relocated shall be removed to points indicated on the Drawings, specified, or acceptable to the Owner. Service lines and wiring not scheduled for reuse shall be removed to the points at which reuse is to be continued or service is to remain. Such services shall be sealed, capped,
or otherwise tied-off or disconnected in a safe manner acceptable to the Owner. All disconnections or connections into the existing facilities shall be done in such a manner as to result in minimum interruption of services to adjacent occupied areas. Services to existing areas or facilities which must remain in operation during the construction period shall not be interrupted without prior specific approval of the Owner as herein above specified.

K. Nighttime Shifts: Certain work during the demolition and alteration phase of construction may require overtime or nighttime shifts or temporary evacuation of the occupants. Coordinate times with the Owner.

L. Include in the contract price all rerouting of existing ductwork, piping, air devices, fixtures, and similar items and the reconnecting of existing fixtures and devices as necessitated by field conditions to allow the installation of the new systems regardless of whether or not such rerouting, reconnecting or relocating is shown on the Drawings. Furnish all temporary ductwork and piping, and similar items as required to maintain service for the existing areas with a minimum of interruption.

M. All existing air devices materials, equipment and appurtenances not included in the remodel or alteration areas are to remain in place and shall remain in service.

N. Mechanical equipment and building systems equipment, and similar items which are to remain but which are served by piping that is disturbed by the remodeling work, shall be reconnected in such a manner as to leave it in proper operating condition.

O. Existing registers, grilles, and diffusers shown to be removed and indicated to be reused, shall be cleaned, repaired and provided with such new accessories as may be needed for the proper installation in their new locations.

P. Within the remodeled or alteration areas where existing ceilings are being removed and new ceilings are installed, all existing air devices, other ceiling mounted devices and their appurtenances shall be removed and reinstalled into the new ceiling, unless otherwise shown or specified.

Q. Within the remodeled or alteration areas where existing walls are being removed, all existing fixtures, thermostats, other materials and equipment and their appurtenances shall be removed and relocated if necessary where required by the remodel work either shown or specified.

R. Any salvageable equipment as determined by the Owner, shall be delivered to the Owner, and placed in storage at the location of his choice. All other debris shall be removed from the site immediately.

S. Equipment, materials or other potential hazards to the public and working occupants of the building shall not be left overnight outside of the designated working or construction areas.

T. All existing air handling equipment which is shown as being reused, shall have coils cleaned and shall be equipped with new filters and belts by this Contractor.

U. No portion of the fire protection systems shall be turned off, modified or changed in any way without the express knowledge and written permission of the Owner's Representative.

V. Refer to Architectural Demolition and Alteration plans for actual location of wall, ceiling, and similar items being removed and/or remodeled.
W. Drawings do not fully indicate conditions or existing obstructions or utilities. Visit the site and examine work to be removed and become familiar with conditions affecting work.

X. Remove ductwork, piping, controls and equipment including previously abandoned mechanical systems full length from source to device. No re-use of existing materials for new construction is allowed except as specifically outlined in the construction documents.

Y. Maintain access to existing mechanical installations that remain active.

Z. Within the renovation or alteration areas where existing ceilings are being removed and new ceilings are installed, all new air devices shall be provided.

3.4 DISPOSITION OF MATERIAL AND EQUIPMENT

A. Review with the Owner materials that have been removed and are no longer required, to determine any which the Owner may desire to keep. Deliver those materials that the Owner desires to the Owner’s specified location.

B. For those materials not required by the Owner, dispose of them in accordance with all applicable regulations.

END OF SECTION
SECTION 23 0593

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 REQUIREMENTS

A. The Bidding and Contract Requirements and General Requirements apply to this work.

B. All Division 21, 22, 23 Sections apply to this work.

C. Section 01 9113, Commissioning.

1.2 SCOPE OF WORK

A. Testing, adjusting, and balancing (TAB) of the air conditioning systems, related ancillary equipment and domestic water system will be performed by an impartial technical TAB firm selected and employed by the Owner.

B. As a part of this Contract, the Contractor and/or Mechanical Subcontractor shall make any changes in the sheaves, belts, dampers, valves, etc. required for correct balance as required by the TAB firm, at no additional cost to the Owner.

C. The Contractor shall ship terminal boxes to the TAB firm for leak testing in his shop prior to installation. Refer to Section 23 3713, Air Devices.

D. The Mechanical Subcontractor shall provide and coordinate services of qualified, responsible subcontractors, suppliers and personnel as required to correct, repair, and/or replace any and all deficient items or conditions found during the testing, adjusting and balancing period.

E. In order that all systems may be properly tested, balanced, and adjusted as required herein by these Sections, the Contractor shall start-up and check-out all systems at his expense for the length of time necessary to properly verify their completion and readiness for TAB. This length of time shall be acceptable to the Owner's Representative.

F. Contract completion schedules shall provide sufficient time to permit the completion of TAB services prior to Owner occupancy.

G. The Drawings and Specifications have indicated valves, dampers, and miscellaneous adjustment devices for the purpose of adjustment to obtain optimum operating conditions, and it will be the responsibility of the Contractor to install these devices in a manner that will leave them accessible and readily adjustable. Should any such device not be readily accessible, the Contractor shall provide access as requested by the TAB firm. Also, any malfunction encountered by TAB personnel and reported to the Contractor or the Inspector shall be corrected by the Contractor immediately so the balancing work can proceed.

H. Contractor must ensure that the necessary systems are scheduled to be in operation for TAB firm so that the access for balancing to diffusers, dampers etc., is not restricted. Contractor
must schedule and coordinate activities so that TAB firm is not restricted from performing work, including access to damper operators and air devices.

I. The Contractor shall correct deficiencies in a timely manner and produce a signed copy of the deficiency lists to the Owner. At that time, the TAB firm will return and verify that the deficiencies are corrected.

1.3 MATERIALS AND WORKMANSHIP

A. The scope of the TAB work as defined herein is indicated in order that the Contractor and/or Mechanical Subcontractor will be apprised of the coordination, adjustment, and system modification which will be required under the project work in order to complete the Owner's requirements for final TAB.

B. The TAB firm will not have a contractual relationship with this Contractor but will be responsible to the Owner's Representative for the satisfactory execution of the TAB work. The Contractor shall allow sufficient funds in the project cost estimate and bid proposal to cover all work which may be required in the TAB phases as defined herein and as may be necessary for the completion of the TAB work as defined by the TAB firm.

1.4 RESPONSIBILITY OF CONTRACTOR

A. The Contractor shall have the building and air conditioning systems in complete operational readiness and shall perform all other items as described hereinafter to assist the TAB Firm in performing the balancing, testing, and adjusting of the air and hydronic systems. He shall promptly correct deficiencies of material and workmanship identified as delaying completion of TAB work. The items shall include the following.

1. Air Distribution Systems:
   a. Verify installation for conformity to design. All supply, return and exhaust ducts terminated.
   b. All volume, splitter, extractor and fire dampers properly located and functional. Dampers shall provide tight closure and full opening, smooth and free operation.
   c. All supply, return, exhaust, transfer grilles, registers, diffusers, and terminal units installed, leak tested and operational.
   d. Air handling systems, units and associated apparatus, such as heating and cooling coils, filter sections, access doors, etc., shall be blanked and/or sealed to eliminate excessively by-pass or leakage of air.
   e. All fans (supply, return, relief and exhaust) operating and verified for freedom from vibration, proper fan rotation and belt tension; overload heater elements to be of proper size and rating; and clean filters installed.

B. Tabulated Data. The motor amperages, voltages and overload heater size of each piece of electrically driven equipment, including exhaust fans, shall be recorded showing "actual" and "nameplate" data and submit to the owner prior to balancing.

C. The Contractor and the suppliers of the equipment installed shall all cooperate with the TAB Firm to provide all necessary data on the design and proper application of the system components and shall furnish all labor and material required to eliminate any deficiencies or malperformance. Furnish a list of all motors with nameplate data and size of overload heater installed with motor amperage during operation.
D. During the balancing the temperature regulation shall be adjusted for proper relationship between controlling instruments and calibrated by the Control Manufacturer using data submitted by the TAB Firm. The correctness of the final setting shall be proved by taking hourly readings for a period of 3 successive eight hour days, in a typical room on each separately controlled zone. The total variation shall not exceed 2 degrees from the preset medium temperature during the entire temperature survey period.

E. In all fans systems, the air quantities shown on the plans may be varied as required to secure a maximum temperature variation of 2 degrees within each separately controlled space, but the total air quantity indicated for each zone must be obtained. It shall be the obligation of the Contractor to furnish or revise fan drives, sheaves, belts, dampers, etc., and/or motors if necessary, without cost to the Owner, to attain the specified air volumes.

F. The Contractor shall assist the TAB Firm in performing 3 inspections within 90 days after occupancy of the building to ensure that satisfactory conditions are being maintained throughout and to satisfy any unusual condition.

1.5 RESPONSIBILITY OF TAB FIRM

A. The services of balancing, testing, and adjusting of the heating, ventilating, and air conditioning systems, including fume hoods and snorkels, will be performed by an independent technical firm or balancing company operating under the same firm name for five years with a minimum of five years specialized experience in the field of air conditioning system balancing, and possessing calibrated instruments, qualified Engineers, and skilled technicians to perform all required tests.

B. The TAB personnel shall check, adjust, and balance the components of the air conditioning system including which will result in optimum noise, temperature, and air flow conditions in the conditioned spaces of the building while the equipment for the system is operating economically. Equipment to be tested includes, but is not limited to, all air handling units, fan coil units, terminal boxes, air devices, pumps, and exhaust fans. This is intended to be accomplished after the system components are installed and operating as provided for in the contract documents, which is the responsibility of the project contractor. Variable air volume systems shall be balanced in accordance with AABC Manual #MN-7 "Variable Volume System Standards."

C. The tests shall demonstrate the specified capacities and operation of all equipment and materials comprising the systems. Such tests shall be made as are deemed necessary by the Architect indicate the fulfillment of the contract. The TAB Firm shall then make available to the Architect such instruments and technicians as are required for spot checks of the systems.

D. The TAB Firm will not instruct or direct the Contractor in any of the work. Any proposed changes or revisions in the work shall be submitted to the Architect/Owner in writing. The Architect/Owner will process the proposal as appropriate.

E. During the balancing process, as abnormalities and malfunctions of equipment or components are discovered by the TAB personnel, the owner shall be advised in writing so that the condition can be corrected by the Mechanical Contractor. The written document need not be formal, but must be understandable and legible. Data from malfunctioning equipment shall not be recorded in the final TAB report. The TAB firm shall not instruct or direct the Contractor in any of the work, but will make such reports as are necessary to the Owner.
1.6 BALANCING SERVICES

A. The TAB Firm, Architect/Engineer and Owner will inspect the installation of heating and cooling pipe systems, sheet metal work, temperature and other component parts of the heating, air conditioning, and ventilating systems. The inspection of the work will cover that part relating to proper arrangement and adequate provisions for the testing and balancing. The inspections shall be performed periodically as the work progresses.

B. Upon formal notification of completion of the installation and start-up of the mechanical equipment by the Contractor, the TAB Firm will balance, test, and adjust the systemic components to obtain optimum conditions in each conditioned space in the building.

C. The TAB Firm shall be responsible for inspecting, balancing, adjusting, testing, and logging the data on the performance of fans, all dampers in the duct systems, all air distribution devices, and the flows of water through all coils.

D. Final Air Balance. When systems are complete and ready for operation, the TAB Consultant will perform a final air balance for all air systems and record the results. The outside, supply, exhaust and return air volume for each air handling unit, supply fan and exhaust fan and the supply, exhaust or return air volume for each distribution device shall be adjusted to within +5% of the value shown on the drawings. Air handling unit and fan volumes shall be adjusted by changing fan speed and adjusting volume dampers associated with the unit. Air distribution device volume shall be adjusted using the spin-in tap damper for flexible duct connected devices and the device OBD for duct connected devices. Air distribution devices shall be balanced with air patterns as specified. Duct volume dampers shall be adjusted to provide air volume to branch ducts where such dampers are shown. The general scope of balancing by the TAB Consultant will include, but is not limited to, the following:

1. Filters: Check air filters and filter media and balance only system with essentially clean filters and filter media. The Division 23 Contractor shall install new filters and filter media prior to the final air balance.
2. Blower Speed: Measure RPM at each fan or blower to design requirements. Where a speed adjustment is required make any required changes.
3. Ampere Readings: Measure and record full load amperes for motors.
4. Static Pressure: Static pressure gains or losses shall be measured across each supply fan, cooling coil, heating coil, return air fan, air handling unit filter and exhaust fan. These readings shall be measured and recorded for this report at the furthest air device or terminal unit from the air handler supplying that device. Static pressure readings shall also be provided for systems which do not perform as designed.
5. Equipment Air Flow: Adjust and record exhaust, return, outside and supply air CFM (s) and temperatures, as applicable, at each fan, blower and coil.
6. Coil Temperatures: Set controls for full cooling and for full heating loads. Read and record entering and leaving dry bulb and wet bulb temperatures (cooling only) at each cooling coil, heating coil and HVAC terminal unit. At the time of reading record water flow and entering and leaving water temperatures (In variable flow systems adjust the water flow to design for all the above readings).
7. Zone Air Flow: Adjust each zone of multizone units, each HVAC terminal unit and air handling unit for design CFM.
8. Outlet Air Flow: Adjust each exhaust inlet and supply diffuser, register and grille to within +5% of design air CFM. Include all terminal points of air supply and all points of exhaust.
9. Pitot Tube Traverses: For use in future troubleshooting by maintenance personnel, all exhaust ducts, main supply ducts and return ducts shall have air velocity and volume measured and recorded by the traverse method. Locations of these traverse test stations shall be described on the sheet containing the data.
10. Maximum and minimum air flow on terminal boxes.
E. Final Chilled and Heating Hot Water Balance. When systems are completed and ready for operation, the TAB Consultant will perform a final water balance for each chilled and hot water system. The general scope of balancing by the TAB Consultant will include, but not be limited to, the following:

1. Adjusted System Tests: Adjust balancing valves at each coil and heat exchanger for design flow, \( \pm 5\% \). Adjust balancing valves at pumps to obtain design water flow. Permanently mark the balanced position for each valve.
2. Temperature Readings: Read and record entering and leaving water temperatures at each water coil. Adjust as necessary to secure design and conditions. Provide final readings at all thermometer well locations.
3. Pressure Readings: Water pressure shall be recorded at all gauge connections. Pressure readings at coils and pumps shall be related to coil and pump curves in terms of GPM flow through flow measuring status, if provided and installed, at each air handler. The flow of water through all water coils shall be adjusted by manipulating valves until the rated pressure drops across each coil is obtained and total water flow is verified by flow measuring status. For coils equipped with 3 way valves, the rated pressure drop shall first be adjusted through the coils. The bypass valve shall then be adjusted on each coil until an equal pressure drop between supply and return connections is the same as with the flow through the coil.
4. Ampere Readings: Reading and record full load amperes for each pump motor.

F. Testing of Temperature Control Systems. In the process of performing the TAB work, the TAB Agency shall:

1. Work with the temperature control contractor to ensure the most effective total system operation within the design limitations, and to obtain mutual understanding of intended control performance.
2. Verify that all control devices are properly connected.
3. Verify that all dampers, valves and other controlled devices are operated by the intended controller.
4. Verify that all dampers and valves are in the position indicated by the controller (open, closed or modulating).
5. Verify the integrity of valves and dampers in terms of tightness of close-off and full-open positions. This includes dampers in multizone units, terminal boxes, and fire/smoke dampers.
6. Observe that all valves are properly installed in the piping system in relation to direction of flow and location.
7. Observe the calibration of all controllers.
8. Verify the proper application of all normally opened and normally closed valves.
9. Observe the locations of all temperature sensors, carbon dioxide sensors and humidity sensors for potential erratic operation from outside influences such as sunlight, drafts or cold walls.
10. Observe the locations of all sensors to determine whether their position will allow them to sense only the intended temperatures or pressures of the media. Control Contractor will relocate as deemed necessary by the TAB Agency.
11. Verify that the sequence of operation for any control mode is in accordance with approved shop drawings and specifications. Verify that no simultaneous heating and cooling occurs.
12. Verify that all controller setpoints meet the design intent.
13. Check all dampers for free travel.
14. Verify the operation of all interlock systems.
15. Perform variable volume system verification to assure the system and its components track with changes from full flow to minimum flow.
16. A systematic listing of the above testing and verification shall be included in the final TAB report.
G. Vibration Test on Air Handling Units.
1. Procedures for Vibration Measurements:
   a. Use a vibration meter meeting the following criteria:
      1) Solid-state circuitry with a piezoelectric accelerometer.
      2) Velocity range of 0.1 to 10 inches per second.
      3) Displacement range of 1 to 100 mils.
      4) Frequency range of at least 0 to 1000 Hz.
      5) Capable of filtering unwanted frequencies.
   b. Calibrate the vibration meter before each day of testing:
      1) Use a calibrator provided with the vibration meter.
      2) Follow vibration meter and calibrator manufacturer's calibration procedures.
   c. Perform vibration measurements when other building and outdoor vibration sources are at a minimum level and will not influence measurements of equipment being tested.
   d. Perform vibration measurements after air and water balancing and equipment testing is complete.
   e. Clean equipment surfaces in contact with the vibration transducer.
   f. Position the vibration transducer according to manufacturer's written instructions and to avoid interference with the operation of the equipment being tested.
2. Location of points:
   a. Fan bearing, drive end.
   b. Fan bearing, opposite end.
   c. Motor bearing, center (if applicable).
   d. Motor bearing, drive end.
   e. Motor bearing, opposite end.
   f. Casing (bottom or top).
   g. Casing (side).
3. Test readings:
   a. Horizontal, velocity and displacement.
   b. Vertical, velocity and displacement.
   c. Axial, velocity and displacement.
4. Normally acceptable readings, velocity and acceleration.
5. Unusual conditions at time of test.
6. Vibration source (if non-complying).

H. The TAB Firm will, fourteen (14) days prior to Final Air Balance Inspection, prepare seven (7) copies of the completed Test and Balance Report. The Report shall be complete with logs, data, and records as required herein and all logs, data, and records shall be typed, produced on white bond paper, and bound with staples and tape. The Report shall be certified and approved by the professional principle Engineer of the TAB Firm and his seal shall appear on the first page of each copy. Transmit one (1) copy direct to the Owner's Representative and the remaining six (6) copies to the Architect. The Architect will review and approve the report. Upon approval, two (2) copies will be submitted to the Owner's Representative and two copies transmitted to the Contractor.

1.7 STANDARDS

A. The TAB Firm shall perform the services in accordance with the Associated Air Balance Council's (AABC) standards and procedures including revisions to the date of the contract.
1.8 STORAGE

A. Refer to Mechanical General Provisions, Section 23 0010. The Contractor shall provide the TAB Firm an area of ample size, conveniently located for storage of tools, equipment, and other items as required.

1.9 NOTIFICATION

A. Systems shall be complete and in operational readiness prior to notifying the Owner that the project is ready for the services of the TAB Firm and the Contractor shall so certify in writing to the Owner that such a condition exists. Systems shall be complete and in operational readiness prior to notifying the Owner that the project is ready for the services of the TAB Firm and the Contractor shall so certify in writing to the Owner that such a condition exists.

B. Should the Owner be not notified and the TAB work commenced and the systems are found to not be in readiness or a dispute occurs as to the readiness of the systems, the Contractor shall request an inspection be made by the Owner. This inspection shall establish to the satisfaction of the represented parties whether or not the systems meet the basic requirements for TAB services. Should the inspection reveal the notification to have been premature, all costs of the inspection and work previously accomplished by the TAB Firm shall be paid for by the Contractor. Furthermore, such items as are not ready for TAB services shall be completed, placed in operational readiness, and TAB services shall again be requested. Complete, operational readiness, prior to commencement of TAB services, shall include the work described in the paragraph "Responsibility of Contractor."

C. Refer to General Provisions. The Contractor shall provide the TAB Firm an area of ample size, conveniently located for storage of tools, equipment, and other items as required.

D. The TAB Firm shall perform the services in accordance with the Associated Air Balance Council's (AABC) standards and procedures including revisions to the date of the contract.
   1. Perform variable volume system verification to assure the temp and its components track with changes from full flow to minimum flow.
   2. A systematic listing of the above testing and verification shall be included in the final TAB report.

PART 2 - PRODUCTS
NOT USED

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
   1. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
B. Examine approved submittal data of HVAC systems and equipment.

C. Examine Project Record Documents described in Division 01 Section, Project Record Documents.

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems’ output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data including fan and pump curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

G. Examine system and equipment test reports.

H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

K. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.

L. Examine plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.

M. Examine strainers for clean screens and proper perforations.

N. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

O. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

P. Examine system pumps to ensure absence of entrained air in the suction piping.

Q. Examine equipment for installation and for properly operating safety interlocks and controls.
R. Examine automatic temperature system components to verify the following:
1. Dampers, valves, and other controlled devices are operated by the intended controller.
2. Dampers and valves are in the position indicated by the controller.
3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
4. Automatic modulating and shut-off valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
6. Sensors are located to sense only the intended conditions.
7. Sequence of operation for control modes is according to the Contract Documents.
8. Controller set points are set at indicated values.
9. Interlocked systems are operating.
10. Changeover from heating to cooling mode occurs according to indicated values.

S. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION
A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:
1. Permanent electrical power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING
A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" and this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.
3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

E. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling unit components.

L. Check for proper sealing of air duct system.

3.5 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outside-air dampers at minimum, and return- and exhaust-air dampers at a position that simulates full-cooling load.

2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.

3. Measure total system airflow. Adjust to within indicated airflow.

4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.
   a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.

8. Record the final fan performance data.

C. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
   1. Balance systems similar to constant-volume air systems.
   2. Set terminal units and supply fan at full-airflow condition.
   3. Adjust inlet dampers of each terminal unit to indicated airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
   4. Readjust fan airflow for final maximum readings.
   5. Measure operating static pressure at the sensor that controls the supply fan, if one is installed, and verify operation of the static-pressure controller.
   6. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.
   7. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems:
      a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
   8. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

D. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
   1. Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.
   2. Adjust supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.
   3. Set terminal units at full-airflow condition.
   4. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
   5. Adjust terminal units for minimum airflow.
   6. Measure static pressure at the sensor.
   7. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
3.6 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
   1. Open all manual valves for maximum flow.
   2. Check expansion tank liquid level.
   3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
   4. Check flow-control valves for specified sequence of operation and set at indicated flow.
   5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
   6. Set system controls so automatic valves are wide open to heat exchangers.
   7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
   8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.7 PROCEDURES FOR HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures, except for positive-displacement pumps:
   1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
   2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
   3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
   4. Report flow rates that are not within plus or minus 5 percent of design.

B. Set calibrated balancing valves, if installed, at calculated presetstings.

C. Measure flow at all stations and adjust, where necessary, to obtain first balance.
   1. System components that have CV rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

E. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
   1. Determine the balancing station with the highest percentage over indicated flow.
2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.

3. Record settings and mark balancing devices.

F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems’ pressures and temperatures including outdoor-air temperature.

G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

3.8 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.9 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
   1. Manufacturer, model, and serial numbers.
   4. Efficiency rating.
   5. Nameplate and measured voltage, each phase.
   6. Nameplate and measured amperage, each phase.
   7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.10 PROCEDURES FOR HEAT-TRANSFER COILS

A. Water Coils: Measure the following data for each coil:
   1. Entering- and leaving-water temperature.
   2. Water flow rate.
   3. Water pressure drop.
   4. Dry-bulb temperature of entering and leaving air.
   5. Wet-bulb temperature of entering and leaving air for cooling coils.
   6. Airflow.
   7. Air pressure drop.

3.11 PROCEDURES FOR TEMPERATURE MEASUREMENTS

A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.
B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

C. Measure outside-air, wet- and dry-bulb temperatures.

3.12 TEMPERATURE-CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).

E. Check free travel and proper operation of control devices such as damper and valve operators.

F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.

G. Check the interaction of electrically operated switch transducers.

H. Check the interaction of interlock and lockout systems.

I. Check main control supply-air pressure and observe compressor and dryer operations.

J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.

K. Note operation of electric actuators using spring return for proper fail-safe operations.

3.13 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
   2. Air Outlets and Inlets: 0 to minus 10 percent.
   3. Heating-Water Flow Rate: 0 to minus 10 percent.
   4. Cooling-Water Flow Rate: 0 to minus 5 percent.

3.14 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
   1. Include a list of instruments used for procedures, along with proof of calibration.
C. Final Report Contents: In addition to certified field report data, include the following:
   1. Pump curves.
   2. Fan curves.
   3. Manufacturers’ test data.
   4. Field test reports prepared by system and equipment installers.
   5. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
   1. Title page.
   2. Name and address of TAB firm.
   3. Project name.
   4. Project location.
   5. Architect's name and address.
   6. Engineer's name and address.
   7. Contractor's name and address.
   9. Signature of TAB firm who certifies the report.
   10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
   11. Summary of contents including the following:
       a. Indicated versus final performance.
       b. Notable characteristics of systems.
       c. Description of system operation sequence if it varies from the Contract Documents.
   12. Nomenclature sheets for each item of equipment.
   13. Data for terminal units, including manufacturer, type size, and fittings.
   14. Notes to explain why certain final data in the body of reports varies from indicated values.
   15. Test conditions for fans and pump performance forms including the following:
       a. Settings for outside-, return-, and exhaust-air dampers.
       b. Conditions of filters.
       c. Cooling coil, wet- and dry-bulb conditions.
       d. Face and bypass damper settings at coils.
       e. Fan drive settings including settings and percentage of maximum pitch diameter.
       f. Inlet vane settings for variable-air-volume systems.
       g. Settings for supply-air, static-pressure controller.
       h. Other system operating conditions that affect performance.

E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
   1. Quantities of outside, supply, return, and exhaust airflows.
   2. Water and steam flow rates.
   3. Duct, outlet, and inlet sizes.
   4. Pipe and valve sizes and locations.
   5. Terminal units.

3.15 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION
SECTION 23 0700
INSULATION - GENERAL

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This Section specifies the general requirements for furnishing and installing insulation. These requirements apply to all other Mechanical Division sections specifying insulation.

B. All the ductwork and piping in pump rooms, mechanical rooms and equipment rooms including areas without ceilings is to be considered as exposed piping or ductwork. This also includes the mechanical chase.

1.2 RELATED WORK

A. Insulation. Refer to specific sections on individual insulation types.

B. Section 09900 or 09901, Painting.

1.3 REFERENCE STANDARDS

A. ASTM International (ASTM).

B. American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc. (ASHRAE).

C. North American Insulation Manufacturers Association (NAIMA).


E. National Fire Protection Association (NFPA).

F. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA).

G. Underwriter's Laboratories (UL).

H. Underwriter's Laboratories Environment (UL Environment).

1.4 FIRE HAZARD RATING

A. All equipment, duct and piping insulation used on the project must have a flame spread rating not exceeding 25 and a smoke developed rating not exceeding 50 as determined by test procedures ASTM E 84, NFPA 255 and UL 723. These ratings must be as tested on the composite of insulation, jacket or facing, and adhesive. Components such as adhesives, mastics and cements must meet the same individual ratings as the minimum requirements.
1.5 QUALITY ASSURANCE:

A. Applicator shall be a company specializing in insulation application with minimum 5 years' experience.

B. Products shall not contain formaldehyde, asbestos, lead, mercury, or mercury compounds.

C. Fiberglass products shall have a minimum of 20 percent recycled glass content certified and UL Validated.

1.6 SUBMITTALS

A. Product Data. Submit product data on each insulation type, adhesive and finish to be used in the work. Include manufacturer's installation instructions, list of materials and thickness for equipment scheduled.

B. Samples. Make an application of each type of insulation to display the material, quality and application method. Obtain approval of the sample application before proceeding with the work.

C. Shop Drawings: Show details for the following:
   1. Application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Attachment and covering of heat tracing inside insulation.
   3. Insulation application at pipe expansion joints for each type of insulation.
   4. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
   5. Removable insulation at piping specialties, equipment connections, and access panels.
   6. Application of field-applied jackets.
   7. Application at linkages of control devices.
   8. Field application for each equipment type.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers are listed under individual specification sections.

2.2 INSULATION

A. Insulate in accordance with appropriate specification section.

PART 3 - EXECUTION

3.1 COMMON INSULATION REQUIREMENTS

A. All materials shall be delivered to the site shall be dry, undamaged and maintained in good condition throughout the progress of the project.
B. Insulation shall not be installed until all testing and inspection of pipe, duct, vessel, etc. has been completed and approved by Engineer/Owner’s representative.

C. Insulate valves, fittings, flanges and special items in accordance with appropriate specification section.

D. Replace insulation damaged by either moisture or other means. Insulation which has been wet, whether dried or not, is considered damaged. Make repairs where condensation is caused by improper installation of insulation. Also replace any damage caused by the condensation.

E. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

F. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

G. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

H. Install insulation with longitudinal seams at top and bottom of horizontal runs.

I. Install multiple layers of insulation with longitudinal and end seams staggered.

J. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

K. Keep insulation materials dry during application and finishing.

L. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

M. Install insulation with least number of joints practical.

N. Where vapor barrier is indicated, seal joints, duct wrap seams, vapor retarder (ASJ) film seams and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier coating/mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier coating/mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

O. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
3.2 ACCESSORIES

A. Installation of accessories such as jacketing, bands, adhesives, insulation shields, coatings, finishes, etc. is specified under individual specification sections.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. This Section provides for furnishing and the installation of external insulation on concealed and exposed ductwork, including single wall supply ductwork, outside air ductwork, and relief and return air duct work in non air conditioned spaces and other miscellaneous ductwork. It also includes insulating the tops of all supply diffusers.

B. All the ductwork exposed to view in public spaces, in mechanical and pump rooms, crawl space and equipment rooms including all areas without ceilings is to be considered as exposed ductwork.

C. Consider space above ceilings air conditioned if floor above is air-conditioned or if the space is a return air plenum.

D. No lined ductwork is allowed on the project unless specifically noted on drawings or in the specifications. Refer to specification 23 31 13 for locations of lined ductwork.

1.2 RELATED WORK

A. Section 23 0700, Insulation - General.

B. Section 23 3113, Ductwork.

1.3 REFERENCES STANDARDS

A. ASTM C 411 - Temperature Range.

B. ASTM C 553 - Mineral Fiber Blanket and Felt Insulation.

C. ASTM C 612 - Mineral Fiber Block and Board Thermal Insulation.

D. ASTM C 1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts

E. ASTM E 96 Procedure A - Jacket Vapor Transmission.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Fiberglass:
   1. CertainTeed.
   2. JohnsManville.
   3. Owens-Corning.

2.2 INSULATION

A. Type D1, Flexible Glass Fiber Insulation: Provide flexible glass fiber insulation; bonded with a formaldehyde free thermosetting resin, with factory-applied, reinforced foil scrim kraft (FSK) facing vapor barrier, 1.0- pound per cubic foot density. A "K" factor of 0.27 at 75°F mean is required. Shall comply with ASTM C553, Types I, II and III, ASTM C 1136, Type II and ASTM C1290, Type III.

B. Type D2, Semi-Rigid Glass Fiber Insulation: Provide semi-rigid glass fiber insulation; bonded with a formaldehyde free thermosetting resin, adhered to UL labeled, reinforced foil scrim kraft (FSK) facing vapor barrier on the outside surface, minimum 2.5 pound per cubic foot density. A "K" factor of 0.23 at 75°F mean is required.

C. Type D3, Rigid Glass Fiber Insulation: Provide rigid board glass fiber duct insulation; bonded with a formaldehyde free thermosetting resin, with integral, UL labeled, reinforced foil scrim kraft (FSK) facing vapor barrier on the outside surface, minimum density of 6 pounds per cubic foot. A "K" factor of 0.22 at 75°F mean is required. Shall comply with ASTM C 612, Type IA or IB.

2.3 COATINGS AND ADHESIVES

A. Glass Fiber Insulation
   1. Coating. Foster 30-80 or Childers CP-38 vapor barrier coating. Permeance shall be 0.05 perms or less as tested by ASTM E96, Procedure A at 47 mils dft or 0.08 perms or less as tested by ASTM F1249. Coating must comply with MIL-PRF-19565C, Type II and be QPL listed.

B. Reinforcing Mesh. Fiberglass or polyester, 10 strands by 10 strands per square inch. Similar to Foster Mast A Fab or Childers Chil Glas #10.

2.4 FACTORY-APPLIED JACKETS

A. FSK Jacket: Aluminum foil, fiberglass reinforced scrim with kraft paper backing; complying with ASTM C 1136, Type II.
PART 3 - EXECUTION

3.1 GENERAL

A. Do not apply insulation until ductwork has been tested.

B. Verify surfaces are clean, foreign material removed, and dry.

C. Where trapeze hangers are used, provide strip of non-compressible insulation between ductwork and hanger. Refer to detail on drawings.

3.2 FIRE SAFETY REQUIREMENTS

A. Do not extend duct coverings through walls or floors required to be fire stopped or required to have fire resistance rating. Interrupt duct coverings in the immediate vicinity of heat sources such as electric resistance or fuel-burning heaters.

3.3 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:
   1. Indoor, concealed supply and outdoor air ductwork.
   2. Indoor, exposed supply and outdoor air ductwork.
   3. Indoor, concealed or exposed return and exhaust ductwork located in nonconditioned spaces.
   4. Indoor, concealed & exposed return air ductwork, from connection of outside air ductwork to air handling unit.

B. Air Devices:
   1. Supply Diffuser.

C. Items Not Insulated:
   1. Indoor, concealed return air ductwork (in chases, above ceilings, except as noted above).
   2. Indoor, exposed return air ductwork (in chases, mechanical rooms except as noted above).
   3. Flexible connectors.
   4. Double wall ductwork.

D. Definitions
   1. Oval ductwork shall be insulated the same as round ductwork.

3.4 DUCTWORK INSULATION APPLICATION AND THICKNESS SCHEDULE

A. Provide insulation with minimum thickness and installed “R” valves in accordance with ASHRAE Standard 90.1-2013 Tables 6.8 2A & B, but not less than thickness specified in this specification and as required to prevent condensation:

<table>
<thead>
<tr>
<th>Ductwork System</th>
<th>Application</th>
<th>Insulation Type</th>
<th>Insulation Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>
### Ductwork System

<table>
<thead>
<tr>
<th>Ductwork System</th>
<th>Application</th>
<th>Insulation Type</th>
<th>Insulation Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply &amp; Outside Air – Rectangular/Round (Hot, Cold, Combination)</td>
<td>Concealed Ductwork</td>
<td>D1</td>
<td>2”</td>
</tr>
<tr>
<td>Supply &amp; Outside Air – Rectangular (Hot, Cold, Combination)</td>
<td>Exposed Ductwork</td>
<td>D3</td>
<td>2”</td>
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<tr>
<td>Supply &amp; Outside Air – Round (Hot, Cold, Combination)</td>
<td>Exposed Ductwork</td>
<td>D2</td>
<td>2”</td>
</tr>
<tr>
<td>Air Devices</td>
<td>Where Scheduled</td>
<td>D1</td>
<td>1”</td>
</tr>
<tr>
<td>Return Air, Relief Air, and Exhaust Air – Rectangular/Round (Hot, Cold, Combination)</td>
<td>Concealed, Where Scheduled</td>
<td>D1</td>
<td>1”</td>
</tr>
<tr>
<td>Return Air, Relief Air, and Exhaust Air – Rectangular (Hot, Cold, Combination)</td>
<td>Exposed, Where Scheduled</td>
<td>D3</td>
<td>1”</td>
</tr>
<tr>
<td>Return Air, Relief Air, and Exhaust Air - Round</td>
<td>Exposed, Where Scheduled</td>
<td>D2</td>
<td>1”</td>
</tr>
</tbody>
</table>

#### 3.5 TYPE D1, FLEXIBLE GLASS FIBER INSULATION

A. Insulation shall be wrapped, in accordance with manufacturer's recommendations, on the ductwork with all circumferential joints butted and longitudinal joints overlapped a minimum of 2 inches.

B. Adhere insulation to ductwork with 4 inch wide strips of adhesive at 8 inches on center. In addition, secure insulation to the bottom of rectangular horizontal ductwork and on vertical ductwork over 24 inches wide by the use of mechanical fasteners at no more than 18 inches on center. Weld stick clips to duct work to secure insulation. Adhesive applied stick pins are not acceptable.

C. On circumferential joints, the 2 inch flange on the facing shall be stapled with outward clinching steel staples on 2 inch centers, and taped with a minimum 3-inch-wide strip of reinforcing mesh and vapor barrier coating. Cover all seams, joints, pin penetrations and other breaks with two coats of vapor barrier coating reinforced with reinforcing mesh. Coating shall completely cover and conceal mesh.

#### 3.6 TYPE D2, SEMI-RIGID GLASS FIBER INSULATION

A. All exposed ductwork in public areas and mechanical rooms shall be wrapped in accordance with manufacturer's recommendations. Firmly butt all joints together and seal longitudinal laps of factory-applied vapor barrier jacket with adhesive. Cover butt joints with a 4 inch wide strip of factory-supplied vapor barrier jacket facing adhered with adhesive. Cover all seams, joints, pin penetrations and other breaks with two coats of vapor barrier coating and reinforcing mesh.

#### 3.7 TYPE D3, RIGID GLASS FIBER INSULATION

A. Exposed ductwork shall be covered with rigid board insulation in accordance with manufacturer's recommendations.
B. Fill and point up all joints, perforations and exposed edges with two coats of vapor barrier coating reinforced with reinforcing mesh. Coating shall completely cover and conceal mesh.

C. Securely fasten insulation to metal surface with mechanical fasteners on 12 inch centers.

D. Mechanical fasteners (weld pins) and discs or other approved fasteners may be used. In addition, secure insulation to the bottom of rectangular horizontal ductwork and on vertical ductwork over 24 inches wide by the use of mechanical fasteners at no more than 18 inches on center. Weld stick clips to duct work to secure insulation. Adhesive applied stick pins are not acceptable.

3.8 STANDING SEAMS

A. Insulate standing seams and stiffeners which protrude through insulation with 3-pound density, 1-1/2 inch thick, faced duct insulation, flexible blanket or rigid insulation to match duct insulation. As a vapor seal on exposed edges, use glass cloth with vapor barrier coating. Insulation should not prevent adjustment of damper operators.

3.9 AIR DEVICES

A. Insulate backside of diffusers and uninsulated plenums on slot diffusers as indicated in application schedule.

B. All edges of insulation should be taped to diffuser backpan with pressure-sensitive aluminum foil tapes listed and labeled under UL 181A, Part I.

3.10 TRANSFER DUCTS

A. Line return air transfer ducts with 1/2 inch dual density type acoustical insulation. Coat exposed edges of insulation with sealant.

3.11 HEATING COILS

A. Install insulation on terminal box heating coil casings same as specified for adjacent ductwork.

3.12 FIRE, FIRE/SMOKE AND SMOKE DAMPERS

A. Insulation Installation at Fire Rated Wall and Partition Penetrations: Terminate insulation at fire, fire/smoke and smoke damper sleeves for fire rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches. Seal insulation to wall.

B. Insulation Installation at Fire Rated Floor Penetrations: For penetrations through fire rated assemblies, terminate insulation at fire and fire/smoke damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches. Seal insulation to floor.

END OF SECTION
SECTION 23 0913
LABORATORY CONTROLS SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The high speed actuators will be used for all Laboratory spaces that have a chemical fume hood requiring full high speed capabilities for proper VAV control. All other spaces will utilize the low speed actuators for general room pressurization control. A laboratory airflow control system shall be furnished and installed to control the airflow into and out of laboratory rooms. The exhaust flow rate of a laboratory fume hood shall be precisely controlled to maintain a constant average face velocity into the fume hood at either a standard/in-use or standby level based on an operator being present in front of the fume hood. The laboratory control system shall vary the amount of make-up/supply air into the room to operate the laboratories at the lowest possible airflow rates necessary to maintain temperature control, achieve minimum ventilation rates, and maintain laboratory pressurization in relation to adjacent spaces (positive or negative). The controllers for the exhaust valves located on level 0 that serve the vivarium and support spaces it is acceptable to provide the Traccel controls, all other controller shall be the Celeris controller. The laboratory airflow control system shall be capable of operating as a stand-alone system, or as a system integrated with the Building Management System (BMS).

1.2 ACCEPTABLE MANUFACTURERS

A. The plans and specifications for the laboratory airflow control system are based on systems and equipment manufactured by Phoenix Controls Corporation.

B. In strict accordance with this specification, alternative laboratory airflow control systems and equipment shall only be considered for approval provided that the equipment be equal in every respect to the operational characteristics, capacities, and intent of control sequences specified herein. Approval to bid does not relieve the laboratory airflow control system supplier from complying with the minimum requirements or intent of this specification.

C. The Engineer and Owner shall be the sole judges of quality and equivalence of equipment, materials, methods, and life cycle cost.

D. Only those systems specifically named in this specification or by addendum shall be considered for approval. Other systems submitted after the bid opening will be returned without review.

1.3 COMPLIANCE SCHEDULE

A. Proposed Equipment

1. The critical airflow control system supplier shall provide a detailed proposal describing all elements of the laboratory control system. A schematic laboratory layout shall be provided, showing relations of these elements and a description of how they interact.

2. Technical specification data sheets shall be provided for all proposed system components and devices.
3. All proposed airflow control devices shall include discharge, exhaust, and radiated sound power level performance obtained from testing in accordance with ARI Standard 880.

B. Experience
   1. The laboratory airflow control system supplier shall provide a list of at least three similar laboratory airflow control systems installed in the state or province as part of this proposal.
   2. The laboratory airflow control system supplier shall provide the names, addresses, and the telephone numbers of the consulting engineer and the owner's representative for each of these installations. It is understood that these individuals may be contacted regarding timely delivery, the quality of installation, the operation and performance of the equipment and the service requirements for each installation. Unsatisfactory performance or inability to provide references shall be grounds for rejection.

C. Performance Verification
   1. The laboratory airflow control system supplier shall demonstrate a typical laboratory space that includes multiple fume hoods, a general exhaust, and a supply airflow control device for the purpose of verifying the laboratory airflow control system's ability to meet the performance requirements indicated in this specification. All travel and lodging costs to witness the performance verification shall be the responsibility of the laboratory airflow control system supplier.

1.4 PREVENTATIVE MAINTENANCE

A. The laboratory airflow control system supplier shall provide at no additional cost to the owner during and after the warranty period, five years of required preventive maintenance on all airflow sensors (e.g., pitot tube, flow cross, orifice ring, air bar, hot wire, vortex shedder, side wall sensors, etc.), and flow transducers if needed, and provided under this section. Airflow sensors shall be removed, inspected, and cleaned annually during the five year period to prevent inaccuracies due to long term buildup from corrosion, lab tissues, wet or sticky particles, or other materials that foul the sensor. If impractical to remove the airflow sensors, the laboratory airflow control system supplier shall include in the proposal the cost of supplying and installing duct access doors, one for each sensor. The transducer shall be checked and recalibrated annually to ensure long-term accuracy. Note that auto-zero recalibration of transducers is not acceptable as a substitute for annual recalibration.

1.5 WARRANTY PERIOD

A. Warranty shall commence upon the date of project substantial completion and extend for a period of twelve months where upon any defects in materials or laboratory airflow control system performance shall be repaired by the supplier at no cost to the owner.

PART 2 - SYSTEM PERFORMANCE REQUIREMENTS

2.1 AIRFLOW CONTROL SYSTEM DESCRIPTION

A. Each individual laboratory shall have a dedicated laboratory airflow control system. Each dedicated laboratory airflow control system shall support a minimum of twenty (20) network controlled airflow devices.
B. The laboratory airflow control system shall employ individual average face velocity controllers that directly measure the area of the fume hood sash opening and proportionally control the hood’s exhaust airflow to maintain a constant face velocity over a minimum range of 20% to 100% of sash travel. The corresponding minimum hood exhaust flow turndown ratio shall be 5 to 1.

C. The hood exhaust airflow control device shall respond to the fume hood sash opening by achieving 90% of its commanded value within one second of the sash reaching 90% of its final position (with no more than 5% overshoot/undershoot) of required airflow. Rate of sash movement shall be between 1.0 to 1.5 feet per second.

D. The hood exhaust airflow control device shall have the capability of automatically switching between in-use and standby levels based on operator presence immediately in front of the hood. A presence and motion sensor shall activate the switching. The airflow control device shall achieve the required in-use commanded value in less than one second from moment of detection with no more than a 5% overshoot or undershoot. Standard room occupancy sensors are not acceptable for hood occupancy control.

E. The laboratory airflow control system shall maintain specific airflow (±5% of signal within one second of a change in duct static pressure) regardless of the magnitude of the pressure change airflow change or quantity of airflow control devices on the manifold (within 0.6” to 3.0” wc) for Medium Pressure Applications or (within 0.3” to 3.0” wc) for Low Pressure Applications.

F. The laboratory airflow control system shall use volumetric offset control to maintain room pressurization. The system shall maintain proper room pressurization polarity (negative or positive) regardless of any change in room/system conditions such as the raising and lowering of any or all fume hood sashes or rapid changes in duct static pressure. Systems using differential pressure measurement or velocity measurement to control room pressurization are unacceptable.

G. The laboratory airflow control system shall maintain specific airflow (±5% of signal) with a minimum turndown requirements as shown below in Table 4 to insure accurate pressurization at low airflow and guarantee the maximum system diversity and energy efficiency without exceeding 2000 FPM velocity through any airflow device and have no deviation or loss of accuracy through the entire range of the flow device.

2.2 AIRFLOW CONTROL SOUND SPECIFICATIONS

A. Unless otherwise specified, the airflow control device shall not exceed the sound power levels in Tables 1, 2 and 3.

B. If the airflow control device cannot meet the sound power level specification, a properly sized silencer or sound attenuator must be used. All silencers must be of a packless design with a maximum pressure drop at the device’s maximum rated flow rate not to exceed 0.20 inches of water.

C. All proposed airflow control devices shall include discharge, exhaust and radiated sound power level performance.
### D. Table 1. Exhaust Airflow Control Device Sound Power Level

<table>
<thead>
<tr>
<th>Octave Band Number</th>
<th>Exhaust Sound Power Level in dB (re: 10-12 watts)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Center Frequency in Hz</td>
<td>125 Hz</td>
</tr>
<tr>
<td>1000-50 CFM Device</td>
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</tr>
<tr>
<td>800 CFM @ 0.6&quot; wc</td>
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</tr>
<tr>
<td>200 CFM @ 0.6&quot; wc</td>
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<tr>
<td>800 CFM @ 3.0&quot; wc</td>
<td>73</td>
</tr>
<tr>
<td>200 CFM @ 3.0&quot; wc</td>
<td>51</td>
</tr>
<tr>
<td>1500-100 CFM Device</td>
<td></td>
</tr>
<tr>
<td>1200 CFM @ 0.6&quot; wc</td>
<td>65</td>
</tr>
<tr>
<td>400 CFM @ 0.6&quot; wc</td>
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</tr>
<tr>
<td>1200 CFM @ 3.0&quot; wc</td>
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</tr>
<tr>
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<tr>
<td>3000-200 CFM Dual Device</td>
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<tr>
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</tr>
<tr>
<td>2400 CFM @ 3.0&quot; wc</td>
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### E. Table 2. Supply Airflow Control Device Sound Power Level (Discharge)

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<th>Octave Band Number</th>
<th>Center Frequency in Hz</th>
<th>2</th>
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</tr>
<tr>
<td>800 CFM @ 0.6'' wc</td>
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<td><strong>1500-100 CFM Device</strong></td>
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F. Table 3. Supply Airflow Control Device Sound Power Level (Radiated)

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</table>

2.3 SYSTEM COMPONENTS

2.4 AIRFLOW CONTROL DEVICE—GENERAL

A. The airflow control device shall be a Celeris venturi valve with an option for 100% shut-off capabilities. The valve assembly manufacturer’s Quality Management System shall be registered to ISO 9001:2000.

B. The airflow control device shall be pressure independent over its specified differential static pressure operating ranges of 0.6”W.C – 3.0”W.C or 0.3”W.C – 3.0”W.C. An integral pressure
independent assembly shall respond and maintain specific airflow within one second of a change in duct static pressure irrespective of the magnitude of pressure and/or flow change or quantity of airflow controllers on a manifolded system.

C. The airflow control device shall maintain accuracy within ±5% of signal over an airflow turndown range as shown in the table below and stated by the venturi’s original manufacturer’s sizing chart in the “Ideal Selection Range” without exceeding 2000 FPM velocity through any airflow device and have no deviation or loss of accuracy through the entire range of the flow device.

D. **TABLE 4**

<table>
<thead>
<tr>
<th>Pressure Drop Range</th>
<th>Airflow</th>
<th>Turndown</th>
<th>Valve Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.6-3.0 in w.c.</td>
<td>Devices up to 1,000 CFM (472 l/s)</td>
<td>20 to 1</td>
<td>Standard</td>
</tr>
<tr>
<td></td>
<td>Devices up to 1,500 CFM (708 l/s)</td>
<td>16 to 1</td>
<td>Standard</td>
</tr>
<tr>
<td></td>
<td>Devices up to 2,500 CFM (1,180 l/s)</td>
<td>12 to 1</td>
<td>Standard</td>
</tr>
<tr>
<td></td>
<td>Devices up to 850 CFM (401 l/s)</td>
<td>17 to 1</td>
<td>Shutoff</td>
</tr>
<tr>
<td></td>
<td>Devices up to 1,300 CFM (614 l/s)</td>
<td>14 to 1</td>
<td>Shutoff</td>
</tr>
<tr>
<td>0.3-3.0 in w.c.</td>
<td>Devices up to 550 CFM (260 l/s)</td>
<td>11 to 1</td>
<td>Standard</td>
</tr>
<tr>
<td></td>
<td>Devices up to 1,050 CFM (496 l/s)</td>
<td>11 to 1</td>
<td>Standard</td>
</tr>
</tbody>
</table>

E. No minimum entrance or exit duct diameters shall be required to ensure accuracy and/or pressure independence.

F. The airflow control device shall maintain accuracy within ±5% of signal over an airflow turndown range without exceeding 2000 FPM.

G. The airflow control device shall be constructed of one of the following three types:

H. Class A - The airflow control device for non-corrosive airstreams such as supply and general exhaust shall be constructed of 16-gauge aluminum. The device's shaft and shaft support brackets shall be made of 316 stainless steel. The pivot arm and internal mounting link shall be made of aluminum. The pressure independent springs shall be a spring-grade stainless steel. All shaft bearing surfaces shall be made of a Teflon, or polyester, or PPS (polyphenylene sulfide) composite.

1. Class B - The airflow control device for corrosive airstreams such as fume hoods and bio-safety cabinets shall have a baked-on corrosion resistant phenolic coating. The device's shaft shall be made of 316 stainless steel with a Teflon coating. The shaft support brackets shall be made of 316 stainless steel. The pivot arm and internal mounting link shall be made of 316 or 303 stainless steel. The pressure independent springs shall be a spring-grade stainless steel. The internal nuts, bolts and rivets shall be stainless steel. All shaft bearing surfaces shall be made of a Teflon or PPS (polyphenylene sulfide) composite.

2. Class C - The airflow control device for highly corrosive airstreams shall be constructed as defined in Paragraph D.2 and, in addition, shall have no exposed aluminum or stainless steel components. Shaft support brackets, pivot arm, internal mounting link, and pressure independent springs shall have a baked on corrosion resistant phenolic coating in addition to the materials defined in paragraph D.2. The internal nuts, bolts, and rivets shall be titanium or phenolic coated stainless steel. Only devices clearly defined as “High Corrosion Resistant” on project drawings will require this construction.

I. For two-position or VAV operation, an electric actuator shall be factory mounted to the valve. Loss of control power shall cause the actuator to fail in last position. When failed in last position, pressure independent airflow control is to be MAINTAINED by the airflow control device during power fail. Electric actuators that fail in last position exclusively are not
acceptable. Tracking pair low speed electric actuators fail in last position, but will continue to control air flow and be pressure independent with no power.

J. The controller for the airflow control devices shall be microprocessor based and operate using a peer-to-peer control architecture. The room-level airflow control devices shall function as a stand-alone network or can be fully integrated.

K. The room-level control network shall utilize a LonTalk communications protocol.

L. There shall be no reliance on external or building-level control devices to perform room-level control functions. Each laboratory control system shall have the capability of performing; Fume hood control, Pressurization control, Temperature control, Humidity control, and implement Occupancy and Emergency mode control schemes.

M. The laboratory airflow control systems shall have digital integration with the BMS through BACnet SIP Ethernet connect.

N. Certification

O. Each airflow control device shall be factory calibrated to the job specific airflows as detailed on the plans and specifications using NIST traceable air stations and instrumentation having a combined accuracy of at least ±1% of signal over the entire range of measurement. Electronic airflow control devices shall be further calibrated and their accuracy verified to ±5% of signal at a minimum of forty-eight different airflows across the full operating range of the device. All flow data for any given device shall be stored at the factory and be available on presentation of the unique serial number within 24 hours. Flow data for all valves shall be stored at a location away from the factory for disaster recovery purposes.

P. All airflow control devices shall be individually marked with device specific, factory calibration data. At a minimum, it should include: tag number, serial number, model number, eight point characterization information (for electronic devices), and quality control inspection numbers. All information shall be stored by the manufacturer for use with as-built documentation.

Q. The system shall be able to offer the following actuation options;

R. Electrically-actuated VAV operation, an electronic actuator shall be factory mounted to the valve. Loss of main power shall cause the valve to remain in last position with standard speed actuators. When fail in last position is used, pressure independent airflow control is to be maintained during power fail with no loss of control. This position shall be maintained constantly without external influence, regardless of external conditions on the valve (within product specifications). Override control schemes which place the flow control devices to an uncontrolled, wide open state, during an emergency, any loss of power, or compressed air condition will not be acceptable.

S. 100% Shutoff Air Valves –
1. 100% Shut-off confirmation is available through a local digital output or an integrated point. The 100% shut-off confirmation is required by positive position verification. Airflow readings for 100% shut off conditions are not acceptable due to inaccurate measurement at no flow conditions.
2. Standard Flow Rates for Medium Pressure Applications only (0.6"W.C.)
   a. 8" Valve – 100% Verified Shut Off - 35 – 600 CFM
   b. 10" Valve – 100% Verified Shut Off - 50 – 850 CFM
   c. Dual 10" Valve – 100% Verified Shut Off - 100 – 1700 CFM
   d. 12" Valve – 100% Verified Shut Off - 90 – 1300 CFM
   e. Dual 12" Valve – 100% Verified Shut Off - 180 – 2600 CFM
T. 100% Shut-off sequence can be initiated through a universal input or remotely via the local area network from the BMS or a Local Display Unit (LDU).

U. The shutoff airflow control device shall have shutoff and casing leakage of no more than:

V. TABLE 5

<table>
<thead>
<tr>
<th>Static Pressure Across Valve in Shutoff</th>
<th>Airflow</th>
<th>Shutoff Leakage</th>
<th>Casing Leakage</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.0 in w.c.</td>
<td>Shutoff devices up to 850 CFM (472 l/s)</td>
<td>6 CFM</td>
<td>0.12 CFM/ ft²</td>
</tr>
<tr>
<td></td>
<td>Shutoff devices up to 1,300 CFM (708 l/s)</td>
<td>6 CFM</td>
<td>0.12 CFM/ ft²</td>
</tr>
<tr>
<td></td>
<td>Low leakage shutoff devices up to 850 CFM (472 l/s)</td>
<td>0.005 CFM</td>
<td>0.010 CFM/ ft²</td>
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<tr>
<td></td>
<td>Low leakage shutoff devices up to 1,300 CFM (708 l/s)</td>
<td>0.010 CFM</td>
<td>0.010 CFM/ ft²</td>
</tr>
</tbody>
</table>

2.5 EXHAUST AND SUPPLY AIRFLOW DEVICE CONTROLLER

A. CELERIS (All Laboratory control valves on this project to be Celeris Model)
   1. The airflow control device shall be a microprocessor-based design and, shall use closed loop control to linearly regulate airflow based on a digital control signal. The device shall generate a digital feedback signal that represents its airflow.
   2. The airflow control device shall store its control algorithms in non-volatile, re-writable memory. The device shall be able to stand-alone or to be networked with other room level digital airflow control devices using an industry standard protocol.
   3. Room-level control functions shall be embedded in and carried out by the airflow device controller using a distributed control architecture. Critical control functions shall be implemented locally, no room-level controller shall be required.
   4. The airflow control device shall use industry standard 24 Vac power.
   5. The airflow control device shall have provisions to connect a notebook PC commissioning tool and every node on the network shall be accessible from any point in the system.
   6. The airflow control device shall have built-integral Input/Output connections address fume hood control, temperature control, humidity control occupancy control, emergency control and non-network sensors switches and control devices. At a minimum the airflow controller shall have:
      a. Three (3) Universal Inputs, capable of accepting 0 to 10Vdc, 4 to 20mA, 0 to 65k ohms, or Type 2 or Type 3 10k ohm @ 25 degree C thermistor temperature sensors.
      b. One (1) Digital Input capable of accepting a dry contact or logic level signal input.
      c. Two (2) Analog Outputs capable of developing either a 0 to 10Vdc, or 4 to 20mA linear control signal.
      d. One (1) Form C (SPDT) relay output capable of driving up to 1A @ 24Vac/Vdc.
   7. The airflow control device shall meet FCC Part 15 Subpart J Class A, and be UL916 listed.
2.6 CONTROL FUNCTIONS

A. The airflow control devices shall utilize a peer-to-peer, distributed control architecture to perform room-level control functions. Master/Slave control schemes shall not be acceptable. Control functions shall at a minimum include, pressurization, temperature, humidity control and respond to occupancy and emergency control commands.

B. Pressurization Control: The laboratory control system shall control supply and auxiliary exhaust airflow devices in order to maintain a volumetric offset (either positive or negative). Offset shall be maintained regardless of any change in flow or static pressure. This offset shall be field adjustable and represents the volume of air, which will enter (or exit) the room from the corridor or adjacent spaces. The pressurization control algorithm shall sum the flow values of all Supply and Exhaust airflow devices and command appropriate controlled devices to new set points to maintain the desired offset. The offset shall be adjustable. The pressurization control algorithm shall consider both networked devices, as well as:
   1. Up to three (3) non-networked devices providing a linear analog flow signal.
   2. Any number of Constant Volume devices where the total of supply devices and the total of exhaust devices may be factored into the pressurization control algorithm.

C. Volumetric offset shall be the only acceptable means of controlling room pressurization. Systems that rely on differential pressure as a means of control shall provide documentation to demonstrate that space pressurization can be maintained if fume hood sashes are changed at the same time a door to the space is opened.

D. The Pressurization control algorithm shall support the ability to regulate the distribution of total supply flow across multiple supply airflow control devices in order to optimize air distribution in the space.

E. Differential Room Pressure is to be monitored by a Critical Room Control CRC-RM
   1. The room pressure controller (Controllers) shall be capable of measuring the differential pressure between two individual spaces at all locations shown on the prints. Each room shall have its own controller capable of stand-alone operation. Each monitor is capable of both visual and audible alarms. Each monitor will use direct pressure measurement utilizing industrial quality differential pressure transducer technology.
   2. Implied pressure measurement systems utilizing thermal (hot wire or thermal mass) air velocity measurement are not acceptable.
   3. Each monitor shall have an easy to navigate microprocessor based controller with full color TFT touch screen interface. Touch screen shall be capable of displaying room conditions in full color i.e. Red screen for alarm. All settings and programming shall be made via simple touch screen. The processor can be custom programmed to allow the end user custom images, messages and icons. The monitor shall have a color TFT / VGA touch display with 240 X 160 resolution, 256 color, and sunlight viewable.
   4. Display shall be fully programmable with custom graphics and fonts. Monitor will store all settings in non volatile memory. Monitor to be capable to incorporate custom JPEG’s or BMP’s for display. Monitor will continually display room differential pressure. Monitor settings shall be accessed via programmable and password protected touch screen. Monitor shall be capable of custom color, graphics and messages per the owner. Monitor shall be recess mounted. Supply voltage shall be 24 volt ac/dc.
   5. Monitors using single or multiple line LCD alphanumeric character displays and or LED indicators are not acceptable. Touch pads and layered programming menus are not acceptable.
   6. The sensor shall continuously monitor and or control bi-directional room pressurization using direct pressure sensing referenced to the adjacent space. Wall / ceiling mounted assembly fittings and stainless steel cover plate for the isolation room shall be provided with the controller as a complete unit
F. Acceptable Manufacturers
   1. The Isolation room system shall be the CRC-RM as manufactured by Critical Room Control (CRC) Milwaukee, Wisconsin Telephone (414) 324-8978 Fax (414) 765-9504 Web Site http://www.criticalroom.com

2.7 PERFORMANCE:
   A. Each monitor will use direct pressure measurement utilizing industrial quality differential pressure transducer technology.

   B. Accuracy Class (F.S.): shall be 0.4 - 0.8%. Accuracy includes the effects of linearity, hysteresis and repeatability. Stability maximum change F.S./year .5%. Monitor shall be bi-directional. Operating temperature shall be -40 to 180 degrees F. The room pressure controller shall be factory calibrated. The room pressure transducer shall factory calibrated with NIST traceable standards.

   C. Each Monitor shall incorporate a high speed microprocessor based controller, designed for critical environment control applications.

   D. Each monitor shall have four (4) universal analog inputs for 4-20mA, 0-5V and 0-10V jumper selectable.

   E. Each monitor shall have two (2) 0-10V and two (2) 4-20mA analog outputs.

   F. Each monitor shall have four (4) digital inputs.

   G. Each monitor shall have four (4) digital Contact (relay) outputs.

   H. Each controller shall have a two (2) wire RS485 serial network interface.

2.8 MOUNTING
   A. Room pressure monitor shall be mounted in the corridor adjacent to the isolation room entrance. Monitor shall be in clear view for staff in corridor.

2.9 MOUNTING
   A. Primary Room Condition Display shall be mounted in the corridor adjacent to the isolation room entrance and above the room pressure monitor. Condition display shall be in clear view for staff in corridor.

   B. Secondary Room Condition Display shall be mounted in associated anti-room adjacent to the isolation room entrance. Condition display shall be in clear view for staff in anti-room.

   C. Temperature Control: The laboratory control system shall regulate the space temperature through a combination of volumetric thermal override and control of reheat coils and/or auxiliary temperature control devices. The laboratory control system shall support up to four separate temperature zones for each pressurization zone. Each zone shall have provisions for monitoring up to five (5) temperature inputs and calculating a straight-line average to be used for control purposes. Separate cooling and heating set points shall be writable from the BMS, with the option of a local offset adjustment. Temperature control shall be implemented through
the use of independent primary cooling and heating control functions, as well as an auxiliary temperature control function, which may be used for either supplemental cooling or heating. Cooling shall be provided as a function of thermal override of conditioned air with both supply and exhaust airflow devices responding simultaneously so as to maintain the desired offset. Heating shall be provided through modulating control of a properly sized reheat coil. The laboratory control system shall also provide the built-in capability for being configured for Hot Deck/Cold Deck temperature control. The auxiliary temperature control function shall offer the option of either heating or cooling mode and to operate as either a stand-alone temperature control loop, or staged to supplement the corresponding primary temperature control loop.

D. Humidity Control: The Laboratory control system shall have an embedded humidity control function, which allows the monitoring and control of the relative humidity level in the pressurized zone. Using peer-to-peer control, the airflow devices shall have the ability to monitor the relative humidity level of the space and, based on a BMS writable set point, develop a control signal to drive one or the other humidification or dehumidification control circuits. The humidity control loop(s) shall share a common set point, with a configurable deadband adjustment to prevent the humidification and dehumidification control functions to operate at the same time.

E. Occupancy Control: The laboratory control system shall have the ability to change the minimum ventilation and/or temperature control set points, based on the occupied state, in order to reduce energy consumption when the space is not occupied. The occupancy state may be set by either the BMS, as a scheduled event, or through the use of a local occupancy sensor or switch. The laboratory control system shall support a local occupancy override button that allows a user to override the occupancy mode and set the space to occupied, for a predetermined interval. The override interval shall be configurable for 1 to 1,440 minutes. The local occupancy sensor/switch, or bypass button shall be given priority over a BMS command.

F. Emergency Mode Control: The laboratory control system shall provide a means of overriding temperature and pressurization control in response to a command indicating an emergency condition exists and airflow control devices are to be driven to a specific flow set point. The system shall support up to four (4) emergency control modes. The emergency control modes may be initiated either by a local contact input, or BMS command. Once an Emergency mode is invoked, pressurization and temperature control are overridden for the period that the mode is active. Emergency modes shall have a priority scheme allowing a more critical mode to override a previously set condition.

G. Airflow Shut-off Function: The air flow control venturi valves shown on the drawings and schedules as type SOV shall be capable of shut off function. Each device shall be capable of accepting a digital input to switch each individual air valve from the set point flow to shutoff position. This valve shall utilize an electric actuator with fail to last position operation. Feedback shall be available to indicate flow and shutoff. Confirmation of shut off shall be available through a digital output. These valves shall also be capable of network operation and being commanded to shutoff position from the BMS.

H. Local Alarm Control: The laboratory control system shall provide the means of summing selective alarm activity at the room-level network and generating a local alarm signal. The local alarm signal may be directed to any available output, as well as to the BMS. The alarm mask may be configured differently for each room-level system.

I. The laboratory control system shall be segregated into individual sub nets to isolate network communications to ensure room-level control functions and BMS communications may be carried out reliably. Each laboratory space, or pressurization zone shall be its own sub net. Commercially available routers shall be used to provide this isolation.
J. The laboratory airflow control system shall support at least 20-networked devices in each pressurized zone.

K. All points shall be available through the interface to the building management system (BMS) for trending, archiving, graphics, alarm notification, and status reports. Laboratory airflow control system performance (speed, stability, and accuracy) shall be unaffected by the quantity of points being monitored, processed, or controlled.

L. Refer to the BMS specification for the required input/output summary for the necessary points to be monitored and/or controlled.

2.10 INTERFACE TO BUILDING MANAGEMENT SYSTEMS

A. The laboratory airflow control system network shall have the capability of digitally interfacing with the BMS. The required software interface drivers shall be developed and housed in a Server, a dedicated interface device furnished by the laboratory airflow control system supplier.

B. Any, or all room-level points shall be available to the BMS for monitoring or trending. The MACRO SERVER shall maintain a cache of all points to be monitored by the BMS. The room-level airflow control devices shall update this cache continually.

C. The building-level network shall be a high-speed LonTalk (1.25 mbps) communications protocol. The building-level network shall support up to one hundred (100) sub nets, or pressurization zones, or six thousand (6,000) data points.

D. A commercially available interface card shall be provided with the Accel-Way in order to connect to the building-level network.

E. A commercially available network interface card shall be provided with the MACROSERVER/MICROSERVER to interface with the BMS. The following points will be available for monitoring:
   1. Makeup/Supply Air Flow - AI
   2. Makeup/ Supply Air Jam Alarm – DI
   4. General Exhaust Air Flow – AI
   5. General Exhaust Air Jam Alarm - DI
   6. General Exhaust Air Alarm - DI
   7. Laboratory Offset – AI
   8. Laboratory Offset Setpoint - AO
   9. Room Differential Pressure – AI (if applicable)
   10. Room Temperature – AI
   11. Room Temperature Setpoint - AO
   12. Cooling / Heating Demand – AO

PART 3 - EXECUTION

3.1 INSTALLATION

A. The laboratory controls contractor (LCC) shall install the sash sensors, interface boxes, presence and motion sensor, and fume hood monitor on the fume hood. Reel-type sash sensors and their stainless steel cables shall be hidden from view. Bar-type sash sensors shall
be affixed to the individual sash panels. Sash interface boxes with interface cards shall be mounted in an accessible location.

B. The LCC shall install all Routers and Repeaters in an accessible location in or around the designated laboratory room.

C. The LCC shall install an appropriately sized and fused 24 Vac transformer suitable for NEC Class II wiring.

D. The LCC contractor shall install 120/24VAC transformers to meet the VA requirements of the High Speed / Low Speed Electric actuators. All 120VAC power for these devices is to be provided by the electrical contractor under Division 16.

E. All cable shall be furnished and installed by the LCC contractor. The LCC contractor shall terminate and connect all cables as required.

F. The mechanical contractor shall install all airflow control devices in the ductwork and shall connect all airflow control valve linkages.

G. The mechanical contractor shall provide and install all reheat coils and transitions.

H. The mechanical contractor shall provide and install insulation as required.

I. Each pressurization zone shall have either a dedicated, single-phase primary circuit or a secondary circuit disconnect.

3.2 SYSTEM START-UP AND TRAINING

A. System start-up shall be provided by a factory-authorized representative of the laboratory airflow control system manufacturer. Start-up shall include calibrating the fume hood monitor and any combination sash sensing equipment as required. Start-up shall also provide electronic verification of airflow (fume hood exhaust, supply, make-up, general exhaust, or return), system programming and integration to BMS (when applicable).

B. The balancing contractor shall be responsible for final verification and reporting of all airflows.

C. The laboratory airflow control system supplier shall furnish a minimum of eight hours of owner training by factory trained and certified personnel. The training will provide an overview of the job specific airflow control components, verification of initial fume hood monitor calibration, general procedures for verifying airflows of air valves, and general troubleshooting procedures.

D. Operation and Maintenance manuals, including as-built wiring diagrams and component lists shall be provided for each training attendee.

END OF SECTION
SECTION 23 0923
DIRECT DIGITAL CONTROLS SYSTEM

PART 1 - GENERAL

1.1 WORK DESCRIPTION

A. Scope: This section contains general requirements for the supply and installation of a microprocessor based Energy Management System (EMS). This system shall be a web accessible (via the internet) front end that integrates the Phoenix Laboratory Controls System (via LON) to a BACnet compatible system. This front-end shall allow the viewing and adjustment of all of the setpoints in the Phoenix Lab Controls System from the web interface.

B. Contractor shall be responsible for furnishing and installing all equipment and wiring for Building Automation Systems (Temperature and HVAC Equipment Control) for a complete and operable system as specified herein. All wiring shall be done in accordance with all local and national codes.

C. Work Included: It is the intent of this specification for the EMS to be installed as a complete package by Phoenix (BacNet). The system shall include all computer software and hardware, controllers, sensors, transmission equipment, local panels, installation, engineering, supervision, commissioning, acceptance test, training, and warranty service.

D. Work includes using communication infrastructure being constructed for this project to allow monitoring and control of the BAS system at the main campus.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Products furnished, but not installed under this section include air flow stations, automatic dampers, valves, flow switches, flow sensors, thermowells and pressure taps to be installed by the Mechanical Contractor.

B. Coordinate VAV terminal unit controls with VAV unit vendor for factory installation of controls furnished under this section.

C. Coordination with electrical:
   1. DDC panel quantity and locations are indicated on the drawings, and Division 26 will route a single 120V circuit to each indicated panel location. Should the EMS contractor require or desire additional power or additional panel locations, the EMS contractor shall provide these at no additional cost. There are a minimum of two spare circuits in each electrical panel that can be used for DDC power. DDC power will come from panels labeled to receive standby power only.
   2. Each motor starter provided under Division 23 or 26, shall be furnished with individual control power transformer to supply 120 volt control power and auxiliary contacts (one N.O. and one N.C.) for use by this section.
   3. Provision by DDC contractor of 24 volt power to each terminal unit. A dedicated 120 V circuit shall be provided in each mechanical room for this purpose.
1.3 QUALIFICATIONS

A. System components shall be provided by Phoenix Controls (BacNet).

B. The control system shall be furnished, engineered and installed by Phoenix Controls branch office having factory trained technicians to provide instruction, routine maintenance, and emergency service within 24 hours upon receipt of request.

C. The control system components shall be new and in conformance with the following applicable standards for products specified:
   1. American Society for Testing and Materials, ASTM
   2. Institute of Electrical and Electronic Engineers, IEEE
   3. National Electrical Manufacturers Association, NEMA
   4. Underwriters Laboratory, UL (UL 916 & 864)
   5. FCC Regulation, Part 15, Section 156
   7. Local Building Codes

1.4 SUBMITTALS

A. The controls contractor shall submit CAD generated schematic drawings for the entire system for review and approval before work shall begin. Included in the submittal drawings shall be a one page diagram depicting the system architecture complete with a communications riser. Drawings shall include point-to-point wiring diagrams and any special connection information required for properly controlling the equipment. The submittal shall include a bill of material reference list as well as equipment sequences of operation.

B. The submittals shall include the manufacturer's catalog data describing, highlighting and specifically indicating each item of equipment or component provided and installed for the project. Submittals shall clearly indicate which features or options shall be included for each submitted item.

C. Product information shall be submitted simultaneously with sequences of operation. Product information submitted prior to sequences of operation shall be returned to contractor unreviewed.

D. Sequences of operation submittals that simply paraphrase or directly copy contract documents will not be acceptable. Sequences of operation shall be sufficiently detailed so that maintenance personnel know which sensors and which controllers and which variables cause control system actions.

E. The Contractor shall prepare shop drawing submittals prior to construction detailing how they will meet all of the above requirements related to Division 25. These submittals will be reviewed by the Division 25 Designer and Contractor to assure completeness and data exchange conformance for complete functionality specified herein.
   1. The submittals related to Division 25 shall include:
      a. Shop Drawings and As Built Drawings showing in technically accurate detail all controllers, relevant equipment, I/Os, sensors, connections, interconnections, and provisions available.
      b. Installation schedule
      c. Location of System Headend
      d. Physical Connection to Division 25 Integrated Automation system
      e. Communication Protocol
1.5 PROTECTION OF SOFTWARE RIGHTS

A. Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:
1. Limiting use of software to equipment provided under these Specifications.
2. Limiting copying.
3. Preserving confidentiality.
4. Prohibiting transfer to a third party.

1.6 SYSTEM REQUIREMENTS AND DIVISION 25 RELATED SCOPE

A. The Contractor must coordinate the data exchange between the system and the Division 25 Integrated Automation System. This involves the format of the data and the validation that all required system points are exposed and available for the Integrated Automation System.

B. The Contractor must determine and identify relevant data points for specific meeting and conference rooms. These points include those associated with air terminals, door locks, lighting zones and audio visual controls.

C. The system(s) contained in this division and section shall provide open protocol communications hardware and software based on the ASHRAE BACnet I/P standards of data exchange. The databases of any sub-system servers shall use MS SQL, MySQL, Oracle or DB2.

D. The Contractor shall program the databases to comply with data exchange rules for the listed protocols including all relevant points and operating parameters for the system. All required set points, schedules and overrides within the system shall be exposed and provide read/write access to the Division 25 software based on the data exchange rule sets and the system functionality.

E. The Contractor shall coordinate with the Division 25 Contractor regarding network addressing, instances, and IDs.

F. The use of IT infrastructure by any building sub-system must meet the Owner's IT standards and policies.

PART 2 - PRODUCTS

2.1 ACCEPTIBLE BIDDERS

A. The specifications are intended to describe the microprocessor based Energy Management System – Phoenix Controls is the acceptable manufacturer/installer.
2.2 MODBUS GATEWAY

A. DDC contractor to provide Modbus gateway that accepts communications and control date in Modbus form and translates it to and from DDC contractor’s communication protocol for the purpose of controlling and receiving information from third party vendors. Contract documents call for Electrical Switchgear, and VFDs to communicate with DDC system using Modbus protocol.

B. DDC contractor to coordinate gateway requirements with vendors of equipment listed above.

2.3 NETWORKING

A. The design of the EMS shall network operator workstations and stand-alone DDC Controllers. The network architecture shall consist of three levels, a campus-wide (Management Level Network - MLN) Ethernet network based on TCP/IP protocol, high performance peer-to-peer Building Level Network (BLN) and Application Specific Controller Floor Level Networks (FLN) with access being totally transparent to the user when accessing data or developing control programs.

B. The design of EMS shall allow the co-existence of new DDC Controllers with existing DDC Controllers in the same network without the use of gateways or protocol converters.

C. All operator devices either network resident or connected via dial-up modems shall have the ability to access all point status and application report data or execute control functions for any and all other devices via the peer-to-peer network. No hardware or software limits shall be imposed on the number of devices with global access to the network data at any time.

D. A single Workstation shall support a minimum of four (4) Building Level Networks (BLN). The BLN’s can be any combination of direct or modem connected Networks. All Networks shall be dynamically connected to allow access to points on different BLN’s simultaneously.

2.4 DDC CONTROLLERS

A. DDC Controllers shall be stand-alone, multi-tasking, multi-user, real-time digital control processors with a minimum word size of 16 bits, minimum 16MHz clock and 4MB memory consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules. Each controller shall support a minimum of 96 FLN Devices. Floor Level Network Controllers (FLNC) are DDC Controllers that only support 96 FLN Devices.

B. Each DDC Controller shall support its own operating system and databases, including:
   1. Control processes
   2. Energy management applications
   3. Alarm management applications including custom alarm messages for each level alarm for each point in the system.
   4. Historical/trend data for points specified
   5. Maintenance support applications
   6. Custom processes
   7. Operator I/O
   8. Dial-up communications
   9. Manual override monitoring
C. Each DDC Controller shall support any combination of industry standard inputs and outputs.

D. Provide all processors, power supplies and communication controllers so that the implementation of a point only requires the addition of the appropriate point input/output termination module and wiring.

E. DDC Controllers shall be provided with one RS-232C serial data communication port for the portable laptop operator's terminal. When a modem is required for remote operation, a second RS-232C serial data communication port shall be provided. DDC Controllers shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers or terminals.

F. The operator shall have the ability to manually override automatic or centrally executed commands at the DDC Controller via local, point discrete, on-board hand/off/auto operator override switches for digital control type points and gradual switches for analog control type points.
   1. Switches shall be mounted within the DDC Controllers key-accessed enclosure.
   2. DDC Controllers shall monitor the status of all overrides and inform the operator that automatic control has been inhibited. DDC Controllers shall also collect override activity information for reports.

G. DDC Controllers shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Graduated intensity LED’s for analog indication of value shall also be provided for each analog output. Status indication shall be visible without opening the panel door (MBC only).

H. Each DDC Controller shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all panel components. The DDC Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.

I. Isolation shall be provided at all peer-to-peer network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standards 587-1980.

J. In the event of loss of all power, there shall be an orderly shutdown of all DDC Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 100 hours.
   1. Upon restoration of normal power, the DDC Controller shall automatically resume full operation without manual intervention.
   2. Should DDC Controller memory be lost for any reason, the user shall have the capability of reloading the DDC Controller via the local RS-232C port, via telephone line dial-in or automatically from the network workstation PC.

K. As a minimum, a separate DDC Controller shall be provided for each mechanical room.

2.5 DDC CONTROLLER RESIDENT SOFTWARE

A. General:
   1. The software programs specified in this Section shall be provided as an integral part of DDC Controllers and shall not be dependent upon any higher level computer for execution.
B. Control Software Description:
   1. The DDC Controllers shall have the ability to perform the following pre-tested control
      algorithms:
         a. Two-position control
         b. Proportional control
         c. Proportional plus integral control
         d. Proportional, integral, plus derivative control
         e. Automatic tuning of control loops

   C. DDC Controllers shall have the ability to perform any or all the following energy management
      routines:
      1. Time-of-day scheduling
      2. Calendar-based scheduling
      3. Holiday scheduling
      4. Temporary schedule overrides
      5. Start-Stop Time Optimization
      6. Automatic Daylight Savings Time Switchover
      7. Night setback control
      8. Enthalpy switchover (economizer)
      9. Peak demand limiting
      10. Temperature-compensated duty cycling

   D. DDC Controllers shall be able to execute custom, job-specific processes defined by the user, to
      automatically perform calculations and special control routines.
      1. A single process shall be able to incorporate measured or calculated data from any and
         all other DDC Controllers on the network. In addition, a single process shall be able to
         issue commands to points in any and all other DDC Controllers on the network.
      2. Processes shall be able to generate operator messages and advisories to operator I/O
         devices. A process shall be able to directly send a message to a specified device or
         cause the execution of a dial-up connection to a remote device such as a printer or
         pager.

   E. Alarm management shall be provided to monitor and direct alarm information to operator
      devices. Each DDC Controller shall perform distributed, independent alarm analysis and
      filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic
      and prevent alarms from being lost. At no time shall the DDC Controllers ability to report alarms
      be affected by either operator or activity at a PC workstation, local I/O device or
      communications with other panels on the network.
      1. All alarm or point change reports shall include the point's English language description
         and the time and date of occurrence.
      2. The user shall be able to define the specific system reaction for each point. Alarms shall
         be prioritized to minimize nuisance reporting and to speed operator response to critical
         alarms. A minimum of six priority levels shall be provided for each point. Point priority
         levels shall be combined with user definable destination categories (PC, printer, DDC
         Controller, etc.) to provide full flexibility in defining the handling of system alarms. Each
         DDC Controller shall automatically inhibit the reporting of selected alarms during system
         shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for
         each point.
      3. Alarm reports and messages will be directed to a user-defined list of operator devices or
         PCs.
      4. In addition to the point's descriptor and the time and date, the user shall be able to print,
         display or store a 200 character alarm message to more fully describe the alarm
         condition or direct operator response.
      5. In dial-up applications, operator-selected alarms shall initiate a call to a remote operator
         device.
F. A variety of historical data collection utilities shall be provided to manually or automatically sample, store and display system data for points as specified in the I/O summary.

1. Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each DDC Controllers point group. Two methods of collection shall be allowed: either by a pre-defined time interval or upon a pre-defined change of value. Sample intervals of 1 minute to 7 days shall be provided. Each DDC Controller shall have a dedicated RAM-based buffer for trend data. All trend data shall be available for use in 3rd party personal computer applications such as Excel 5.0.

2. DDC Controllers shall also provide high resolution sampling capability for verification of control loop performance. Operator-initiated automatic and manual loop tuning algorithms shall be provided for operator-selected PID control loops as identified in the point I/O summary.
   a. Loop tuning shall be capable of being initiated either locally at the DDC Controller, from a network workstation or remotely using dial-in modems. For all loop-tuning functions, access shall be limited to authorized personnel through password protection.

G. DDC Controllers shall automatically accumulate and store run-time hours for digital input and output points and automatically sample, calculate and store consumption totals for analog and digital pulse input type points, as specified in the point I/O summary.

H. DDC Controllers shall be password protected. The user’s Password and Privileges shall be identical to the Password and Privileges used at the EMS Workstation.

2.6 APPLICATION SPECIFIC CONTROLLERS

A. TERMINAL EQUIPMENT CONTROLLERS (TEC)

1. Provide for control of each piece of equipment, including, but not limited to, the following:
   a. VAV Terminal Units with and without heating coils
   b. FVV Terminal Units with and without heating coils
   c. Fan Coil Units

2. The controllers shall include all inputs and outputs necessary to perform the specified control sequences. Analog outputs shall 24 volt floating.

3. Each controller performing space temperature control shall be provided with a matching room temperature sensor with a setpoint adjustment between 55 °F and 95°F.

4. Each room temperature sensor shall include a terminal jack integral to the sensor assembly. The terminal jack shall be used to connect a portable operator's terminal to control and monitor all hardware and software points associated with the respective controller.

5. Setpoint adjustment and override function shall have the ability to be locked out, overridden, or limited as to time or temperature through software by an authorized operator at the central workstations, at the DDC Controller, or via the portable operator's terminal.

6. Each controller shall perform its primary control function independent of the DDC Controller. The controller shall receive its real-time data from the DDC Controller time clock. Each controller shall include algorithms incorporating proportional, integral, and derivative (PID) gains for all applications. All PID gains and biases shall be adjustable by the user via terminals as specified herein. This functionality shall allow for tighter control and shall facilitate optimal occupant comfort and energy savings.

7. Provide each terminal equipment controller with sufficient memory to accommodate point databases and operating programs. All databases and programs shall be stored in non-volatile EEPROM, EPROM, and PROM. The controllers shall be able to return to full normal operation without user intervention after a power failure. Operating programs
shall be selectable and may be modified to meet the user's exact control strategy requirements, allowing for additional system flexibility:

8. Controllers shall be powered from a 24 VAC source, and shall function normally under an operating range of 18 to 28 VAC (-25% to +17%), allowing for power source fluctuations and voltage drops. The controllers shall also function normally under ambient conditions of 32 Degrees to 122 Degree F and 10-95% RH (non-condensing). Provide each controller with a suitable cover or enclosure to protect the intelligence board assembly.

9. Pressure independent controllers shall include differential pressure transducers that shall connect to the terminal unit manufacturer’s standard averaging air velocity sensor to measure the average differential pressure in the duct. The controller shall convert this value to actual airflow. The differential pressure transducer shall have a measurement range of 400 to 4,000 FMP and measurement accuracy of +/-5% at 400 FPM ensuring primary air flow condition shall be controlled and maintained to within +/-5% of setpoint at the specified parameters. Each controller shall include provisions for manual and automatic calibration of the differential pressure transducer in order to maintain stable control and insuring against drift overtime. The controller requiring 24 hours a day operation shall calibrate the airflow sensor every 24 hours with the use of an auto-zero module to eliminate the requirement of closing the supply damper to calibrate the flow sensor. It shall not be necessary to remove the controller to remove the damper actuator.

2.7 VALVES, DAMPERS AND ACTUATORS

A. VALVES:

1. Water valves shall be sized by the control manufacturer to produce the required capacity at a pressure loss of 5 psi. Nominal body rating shall be not less than ANSI Class 125. However, the valve body and packing selected shall be designed to withstand the system static head plus the maximum pump head and the maximum temperature of control medium and hot water. Single-seated valves shall have close-off ratings equal to 125% of the system pressure encountered that is the maximum upstream pressure. The valve body and packing selected shall be designed to withstand the system static head plus the maximum pump head and the maximum temperature of control medium without leakage for hot water.

2. Two-Way Valves:
a. Valves used for control of hot and chilled water shall be of the modulating ball type.
   b. Valve sizes two inch and smaller shall be screwed and supplied with union fittings. The valves shall be constructed of bronze with stainless steel trim.
   c. Valve sizes 2.5 inch and larger shall be flanged. The valves shall be constructed of cast iron ASTM A126 Class B. The trim shall be stainless steel.
   d. Valves shall be of the straight-through type as required by the sequence or indicated on the drawings.
   e. Valves for preheat coils on PTOA units with enthalpy wheels shall be fast acting valves with a full open time of less than 20 seconds. This is to prevent the unit freeze-stat from tripping if the enthalpy wheel is shut off.

3. Butterfly Valves: Where butterfly valves are indicated to be used as automatic control valves, they shall be line size and designed for motorized control operation with upper disc steam keyed or machined square for mating with the control operator’s linkage. All butterfly control valves over 8 inches shall be equipped with a manual, mechanical control actuator override, gear box operator for emergency manual control of the valve position. Provide required accessories to mechanically disengage automatic control actuator linkage and engage manual gear operator without dismantling the valve stem and stem extensions during changeover. Valves 4-20” and larger shall be tapped, full lug, cast iron body butterfly valves with aluminum bronze discs, stainless steel stem and EPDM seat. Design must incorporate top and bottom bushings between shafts and body
of material suitable to provide a bearing surface to eliminate seizing or galling. Valves 4-20" must provide bubble-tight seal at 150 PSIG. Liners are to be resilient material suitable for 250°F.

4. Valve Constant (Cv) Charts: Control drawings shall indicate the valve constant (Cv rating) of all valves used so that the valve pressure drop may be used for balancing and performance tests. Submittal data shall also state calculated shut-off pressure for each valve size.

B. STANDARD CONTROL DAMPERS:

1. The Temperature Control Manufacturer shall provide control dampers of the types and sizes indicated on the drawings, including but not limited to outside air, return, relief air dampers, isolation and exhaust system bypass dampers. Control dampers provided as part of the air handling units shall be provided by the air handling unit manufacturer according to these specifications. Actuators shall be provided by the control systems contractor.

2. Damper frames shall be 5" X 1" 6063T5 extruded aluminum hat channel with .125" minimum wall thickness with mounting holes for flange and enclosed duct mounting.

3. Dampers shall be available in two-inch size increments from 8" horizontal and vertical to 48". Requirements over 48" shall be standard modules with interconnecting hardware (jack shafting).

4. All damper blades shall be 6" 6063T5 heavy gage extruded aluminum airfoil for high velocity performance. Blades on all dampers must be not over 6" wide. Blade bearing shall be molded synthetic with 1/2" hex plated steel shafts. All blade linkage hardware shall be of corrosion-resistant finish and readily accessible for maintenance after installation.

5. Extruded vinyl edging seals for outdoor dampers and flexible metal compressible type side seals for all dampers shall be provided.

6. Dampers and seals shall be suitable for temperature ranges of -50 Degrees F. to +250 Degrees F. at specified leakage ratings.

7. Dampers used for proportional control shall have opposed blades.

8. Leakage rates shall not exceed 6.25 CFM/Sq. Ft. at 4" wg. differential rated in accordance with AMCA 500.

9. Acceptable manufacturers are Ruskin, Arrow United Industries, American Warming and Ventilating, Inc., Greenheck, or approved equal.

C. DAMPER AND VALVE ACTUATORS:

1. Electronic actuators shall be of 0-10 VDC type. The minimum actuator impedance shall be 800 ohms even when more than one actuator is connected in parallel. Spring return shall be required for two-position (NO/NC) control sequence or for steam valve control. Non-spring return actuators shall be used for all modulating sequence of control. They shall conform to all requirements of sequence descriptions specified or scheduled. Main mechanical equipment actuators shall have a manual position dial to allow manual positioning of valve in absence of control power.

2. Valve actuators shall be of sufficient size to close valves at system pressure drop across the valve plus 50%.

3. Actuators for Terminal Equipment Controllers shall be 24V floating point, 0-10Vdc or pneumatic depending on Sequence of Operation and required speed of response. Regardless of actuator type, they shall be modulating and their position shall be readable in percentage open at the Workstation.

4. Actuators for VAV Laboratory Applications shall be provided for Laboratory Supply Air Terminals, Laboratory General Exhaust Terminals and Fume Hood Exhaust Terminals. The actuators shall be maintenance free high-speed actuators capable 1.0 second from minimum flow to 90% of maximum flow. The actuators shall have a fail safe position based on Sequence of Operation. The actuators shall be capable of accepting either 3-position floating point or 0-10 Vdc.
2.8 FLOW STATIONS

A. Airflow measuring stations:
   1. Airflow measuring stations shown outside of the fans or air handling units shall be EBTRON with gold series transmitters or other manufacturer with equal accuracy and straight run requirements.

B. Fan Inlet Flow Measuring Devices
   1. Where indicated, fan inlet flow measuring probes and transmitters will be furnished by fan manufacturer. EMS contractor to provide control power and wiring from transmitter to EMS panel.

2.9 FIELD SENSORS

A. Temperature Sensors:
   1. The sensor shall be one of the following temperature sensor types:
      a. 1000 ohm (±0.2%) platinum resistance temperature detectors having a coefficient of resistivity of 0.00385 ohms/ohm/°C (for animal room locations).
      b. 100 ohm (±0.12%) platinum resistance temperature detectors having a coefficient of resistivity of 0.00385 ohms/ohm/°C. Provide RTD temperature transducers with of 4-20 ma output signal variations of less than 0.2% of full scale output for supply voltage variations +/-10% and integral and accessible zero and span adjustment.
      c. 10,000 ohm thermistor having an accuracy of .5°F at calibration point of 77°F may be used for room temperature only.
      d. Immersion temperature sensors shall have 316 Stainless Steel wells and duct mounted sensors shall use averaging bulbs of not less than 24" and when mounted in the preheat or mixed air position the averaging bulb shall be twice the diagonal length of the coil or duct.

B. Humidity Sensors:
   1. The sensor shall be a space or duct mounted relative humidity sensors and transducers having an operating range of 0 to 100% of R.H. with a combined accuracy of sensor and transducer ± 2.0%. The output from the transducer shall be 4-20 ma or 0-10Vdc into a maximum of 500 ohms load.

C. Carbon Dioxide Sensor:
   1. The sensor shall be a duct mounted microprocessor-based photo-acoustic CO2 sensor to read CO2 levels in the return air. The sensor shall have a range of 0-2000 ppm with an accuracy of ± 100 ppm. CO2 sensor shall be Siemens QPA63 Series or equal.

D. Pressure Sensors:
   1. The sensor shall be an air differential pressure transducers with output of 4-20 ma proportional to pressure. The airflow transmitter will have an accuracy of at least ±0.5% F.S for velocity pressure applications and ±1.0% F.S for static pressure applications. Airflow transmitter shall be either Dresser Industries Ashcroft Model XLDp or Setra C264 Lab.
   2. The sensor shall be a water or steam differential pressure transducers with output of 4-20 ma proportional to pressure. The transmitter will have an accuracy of at least ±0.2% of the transmitter range. The transmitter shall be Rosemount Series 1151 or equal.
E. Low Limit Temperature Switch
   1. The sensor shall be a Low Limit Temperature Switch with minimum 20 ft. element for freeze protection as specified hereinafter. Element shall be serpentine across the face of the coil and shall be of sufficient length or number for three passes across the width of the coil it is protecting. Connect Low Limit Temperature Switch in series with other safety devices to de-energize fans serviced when a drop in temperature below setpoint is detected.

F. Differential Pressure Switches:
   1. The sensor shall be a pressure switch to monitor the pressure drops across each piece of equipment specifically a filter banks.
   2. Design and sensitivity shall match application, with SPDT contacts to make/break from a field adjustable differential pressure setting for alarm reporting to the EMS. Switches utilized for filter banks shall be Powers Static Pressure Air Flow Switches Series SW 141 or equal.

G. Current Status Switch (CSS)
   1. The sensor shall be a high performance miniature split-core current status switch with adjustable set point. The current status switch shall have an operating range of between 1.25 – 50 amps and be able to detect belt loss and mechanical failure. CSS shall be Veris Hawkeye H908 or equal.

H. Pressure Electric Switch (PE)
   1. The sensor shall be a pressure operated snap switch that can actuate electrical circuits. The contact ratings shall be 8 amps at 240V inductive.

I. Instantaneous Flow Meters
   1. Provide magnetic flow meter by Rosemount, Badger or equal rated for 250 deg F and sized per the schedule. Meter to include flow element and remote digital display with 4-20 ma output signal. Flow meters for potable water service shall have PTFA liner.

2.10 LOCAL CONTROL PANELS

A. Provide control panels with suitable brackets for wall mounting, for each miscellaneous control system. Locate panel adjacent to systems served.

B. Fabricate panels of 14-gauge furniture-grade steel, or 6063-T5 extruded aluminum alloy, totally enclosed, with hinged doors and keyed lock, with manufacturer's standard shop-painted finish and color. Provide UL listed cabinets for use with line voltage devices.

C. Panel Mounted Equipment: Include temperature controllers, relays, and other devices excluded in the sequence of operation. Mount devices with adjustments accessible through the fronts of panels.

2.11 WORKSTATION

A. Provide a new workstation Windows 7 Professional PC, quad core processor, 8 GB of ram, 7200 rpm 500 GB hard drive, mouse, DVD-drive, dual monitor video card capable of supporting specified monitors, one 24” and one 32” monitor. Workstation shall be located in the main mechanical room located on level 1 area E.
2.12 WORKSTATION SOFTWARE 

A. The new workstation shall be a client to the existing server located on the main campus. Provide one additional seat license to the DDC software.

PART 3 - EXECUTION

3.1 PROJECT MANAGEMENT 

A. Provide a project manager who shall, as a part of his duties, be responsible for the following activities: 
   1. Coordination between this Contractor and all other trades, Owner, local authorities and the design team. 
   2. Scheduling of manpower, material delivery, equipment installation and checkout. 
   3. Maintenance of construction records such as project scheduling and manpower planning and Auto CAD for project coordination and as-built drawings.

3.2 INSTALLATION METHODS 

A. Electrical Wiring 
   1. Install systems and materials in accordance with manufacturer's instructions, rough-in drawings and equipment details. Install electrical components and use electrical products complying with requirements of applicable Division 16 Sections of these Specifications except where specifically stated in this Section. 
   2. The term "control wiring" is defined to include providing of wire, conduit, and miscellaneous material as required for mounting and connecting electric or electronic control devices. 
   3. Install all control wiring in conduit for electric/electronic control systems. Conceal wiring, except in mechanical rooms and areas where other conduit and piping are exposed. UL plenum rated cable shall be allowable above accessible lift out ceiling, in air plenums, and in other areas as approved by local and NEC codes. 
   4. Wall sensors shall be installed on electrical "J" boxes and conduit stubbed to above lift out ceilings. Plastic bushing shall be installed where the sensor wire exits the conduit to prevent damage. 
   5. Number-code or color-code conductors, excluding those used for individual zone controls, appropriately for future identification and servicing of control system. 
   6. This section shall provide all line voltage power wiring required because of substitution of equipment specified in this section. 
   7. Division 16 shall provide 120 volt power to all DDC Controllers specified in paragraph 2.3 of this Section.

3.3 SYSTEM ACCEPTANCE 

A. General: The system installation shall be complete and tested for proper operation prior to acceptance testing for the Owner's authorized representative. A letter shall be submitted to the Architect requesting system acceptance. This letter shall certify all controls are installed and the software programs have been completely exercised for proper equipment operation. Acceptance testing will commence at a mutually agreeable time within ten (10) calendar days of request. When the field test procedures have been demonstrated to the Owner's Representative, the system will be accepted. The warranty period will start at this time.
B. Field Equipment Test Procedures: DDC control panels shall be demonstrated via a functional end-to-end test. Such that:
   1. All output channels shall be commanded (on/off, stop/start, adjust, etc.) and their operation verified.
   2. All analog input channels shall be verified for proper operation.
   3. Changing the state of the field device and observing the appropriate change of displayed value shall verify all digital input channels.
   4. If a point should fail testing, perform necessary repair action and retest failed point and all interlocked points.
   5. Introducing an error into the system and observing the proper corrective system response shall verify automatic control operation.
   6. Changing the schedule and observing the correct response on the controlled outputs shall verify selected time and setpoint schedules.

C. Workstation Test Procedures: The system workstation test procedures shall be as follows:
   1. Communication with each DDC control panel shall be demonstrated.
   2. Operator commands will be explained and demonstrated.
   3. Control sequences shall be demonstrated for proper operation.
   4. All available system reports and logs shall be demonstrated at the system workstation.
   5. Correct system start-up and shutdown procedures shall be demonstrated.
   6. All controllers shall be demonstrated to operate in a standalone mode.

D. Record Documentation: After a successful acceptance demonstration, the Contractor shall submit as-built drawings of the completed project for final approval. After receiving final approval, supply "6" complete 11 x 17 as-built drawings sets.

E. Operation and Maintenance Manuals: Submit three copies of operation and maintenance manuals. Include the following:
   1. Manufacturer’s catalog data and specifications on sensors, transmitters, controllers, control valves, damper actuators, gauges, indicators, terminals and any miscellaneous components used in the system.
   2. An operator's manual that will include detailed instructions for all operations of the system.
   3. An operator's reference table listing the addresses of all connected input points and output points. Settings shall be shown where applicable.
   4. A programmer's manual that will include all information necessary to perform programming functions.
   5. A language manual that will include a detailed description of the language used and all routines used by the system.
   6. Complete program listing file and parameter listing file for all programs.
   7. A copy of the warranty.
   8. Operating and maintenance cautions and instructions.
   9. Recommended spare parts list.

3.4 TRAINING

A. Contractor shall provide to the engineer a training class outline prior to any scheduled training.

B. Factory trained control engineers and technicians shall provide training sessions for the Owner’s personnel.

C. The control contractor shall conduct five six-hour training sessions on the DDC System for the designated Owner's personnel in the maintenance and operation of the Systems. The class shall be given upon system acceptance.
D. The course shall include instruction on specific systems and instructions for operating the installed system to include as a minimum:
   1. HVAC system overview
   2. Operation DDC Systems
   3. Function of each Component
   4. System Operating Procedures
   5. Programming Procedures
   6. Maintenance Procedures

3.5 SERVICE AND GUARANTEE

A. This system specified under this Section of the Specifications shall be guaranteed from defects in workmanship and material under normal use and service for a period of twelve (12) months from the date of acceptance. If, during the one year period, any of the factory equipment or materials provided in the system is found to be defective in materials or workmanship, it shall be replaced or repaired by the DDC Manufacturer at no additional cost to the Owner.

B. Upon completion of the installation, the Contractor shall thoroughly inspect, check, adjust, calibrate, and make ready for use all devices/sensors comprising the control system and certify that they are installed in accordance with "Record" Drawings.

3.6 INPUT/OUTPUT SUMMARY

A. The I/O Summary at the end of this section is provided as a list of the minimum points required by this contract for connection to the Owner's Energy Management system. Furnish all devices, wiring, tubing, etc., necessary to serve and transmit to the Owner's panels. Any points not shown on the I/O Summary yet required to accomplish the sequence of operation shall be provided under this contract at no additional cost to the Owner.

B. LAMINATED SEQUENCE OF OPERATION
   1. For each piece of equipment, including, but not limited to boilers, pumps, air handling units, fans, fan coil units, etc., provide a laminated sequence of operation, including control schematic, to be mounted on the wall in the mechanical rooms or at location as indicated by Owner.

END OF SECTION
SECTION 23 3113

DUCTWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Perform Work required to provide and install ductwork, flexible duct, hangers, supports, sleeves, flashings, vent flues, and all necessary accessories as indicated in the Contract Documents. Provide any supplementary items necessary for proper installation.

B. Section Includes:
   1. Rectangular ducts and fittings.
   2. Round ducts and fittings.
   3. Oval ducts and fittings.
   4. Fume hood ductwork.
   5. Double-Wall Ductwork
   7. Sealants and gaskets.
   8. Hangers and supports.

C. Related Sections:
   1. Division 09 Section, Painting, for interior painting of metal ductwork exposed to view through grilles, registers, and other openings.
   2. Section 23 0593, Testing, Adjusting, and Balancing for HVAC, for testing, adjusting, and balancing requirements for metal ducts.
   3. Section 23 0713, External Ductwork Insulation.
   4. Section 23 3300, Ductwork Accessories, for dampers, spin-in fittings, flexible duct connections.
   5. Section 23 3413, Fans.
   6. Section 23 3600 Air Terminal Units
   7. Section 23 3713, Air Devices.

1.2 DEFINITIONS

A. Low Pressure: Up to 2 inches w.g. positive or negative static pressure and velocity equal to 1500 fpm. Constructed and tested for +2 inches W.G.

B. Medium Pressure: Over 2 inches w.g. through 6 inches w.g. positive or negative static pressure and velocity greater than 1500 fpm. All medium pressure ductwork shall be constructed and tested for +6 inches w.g.

C. High Pressure: Over than 6 inches w.g. positive static pressure and velocity greater than 2500 fpm.

D. Duct Size. The supply, return and exhaust duct sizes shown on drawings are clear inside sheet metal dimensions. Include proper allowances for acoustical lining, where indicated in plans or specifications. For acoustical return air boots, refer to additional information on detail.
1.3 GUARANTEE

A. Guarantee all ductwork for 1 year from the date of final acceptance. The guarantee will cover workmanship, noise, chatter, whistling or vibration. Ductwork shall be free from pulsation under all conditions of operation.

1.4 CONTRACTOR COORDINATION

A. Erect all ducts in the general locations shown on the drawing(s), but conform to all structural and finish conditions of the building. Before fabricating any ductwork, Contractor to check the physical conditions at the job site and make all necessary changes in cross sections, offsets and similar items, whether they are specifically indicated on drawing(s) or not. Do not obstruct the induced air plenum opening at VAV boxes and service access spaces for VAV boxes and other equipment.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

1.5 STANDARDS AND CODES

A. Except as otherwise indicated, sheet metal ductwork material, fabrication and installation shall comply with second edition of SMACNA HVAC Construction Standards Metal and Flexible, except where indicated otherwise. All air distribution devices (such as dampers) included in this Section shall comply with the second edition of SMACNA HVAC Construction Standards Metal and Flexible.

B. In addition, construct ductwork and all air distribution devices to the following:
   1. IMC International Mechanical Code
   2. NFPA 90A Installation of Air Conditioning and Ventilating Systems.
   3. NFPA 90B Installation of Warm Air Heating and Air Conditioning Systems
   4. NFPA 45 – Laboratory Ventilating Systems and Hood Requirements
   5. SMACNA Round Industrial Duct Construction Standards
   6. SMACNA The Managers’ Guide for Welding

1.6 SUBMITTALS

A. Product Data
   1. Submit product data for each product. Refer to Section 23 0010.
   2. Provide acoustical data on insulated flexible ductwork as indicated in Part 2.

B. Delegated-Design Submittal. Include the following for each system furnished on the project.
   1. System name and type
   2. Duct system design pressure.
   4. Reinforcement details and spacing.
   5. Seam and joint construction and sealing.
   6. Fittings, construction and details.
7. Hangers and supports, including materials, fabrication, methods for duct and building attachment.
8. Provide detail of breakaway connections for fire, fire/smoke and smoke dampers for review.

C. Ductwork shop drawings. Provide CAD-generated shop drawings of mechanical rooms and building ductwork drawn at a minimum scale of ¼ inch per foot. Include the following as a minimum:
1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory and shop fabricated duct and fittings.
3. Duct layout indicating sizes, configuration and pressure classes.
4. Elevations of top and bottom of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Reinforcement and spacing.
7. Penetrations through fire-rated and other partitions.
8. Equipment installation based on equipment being used on Project.
9. Duct accessories, including access doors and panels, fire dampers and smoke dampers.

D. Samples.
1. Provide a sample of stainless steel welded duct joint to Engineer and Owner for approval. Submit sample prior to duct fabrication. After approval, the sample shall remain at the jobsite for reference.

E. Welding certificates. For duct welders including procedures and standards of acceptance

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Spiral Ductwork. Gowco, McCorvey, United McGill, Lindab (supply duct only).
B. Sheet Metal Products. McCorvey Sheet Metal Works, Gowco, United McGill, Flexmaster
C. Insulated Flexible Duct. Peppertree Air Solutions, Thermaflex, Flexmaster.

2.2 APPLICATION

A. Ductwork shall be constructed in accordance with the following as a minimum. Refer to drawings for any deviations from this table.

<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>MATERIAL</th>
<th>MINIMUM PRESSURE CLASSIFICATION (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Systems:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All ductwork downstream of terminal boxes</td>
<td>Galvanized Steel</td>
<td>Low Pressure</td>
</tr>
<tr>
<td>All fan coil unit supply ductwork</td>
<td>Galvanized Steel</td>
<td>Low Pressure</td>
</tr>
<tr>
<td>Supply ductwork downstream of con-</td>
<td>Galvanized Steel</td>
<td>Low Pressure</td>
</tr>
</tbody>
</table>
### Ductwork 23 3113 - 4

#### SYSTEM | MATERIAL | MINIMUM PRESSURE CLASSIFICATION
--- | --- | ---
stant volume single and multi-zone AHUs. | | |
Supply ductwork downstream of single zone VAV AHUs | Galvanized Steel | Medium Pressure
Mixed air AHU plenum | Galvanized Steel | Medium Pressure
Treated outside air to AHU | Galvanized Steel | Medium Pressure
Inlet connection to terminal box | Flexible Duct | As Specified
Connection to Air Device | Flexible Duct | As Specified

**Return Systems:**

Return air boot/transfer duct | Galvanized Steel | Low Pressure
Return air device to return distribution | Galvanized Steel | Low Pressure
Return Air Distribution | Galvanized Steel | Medium Pressure

**General Exhaust/Relief Systems:**

Exhaust air device to exhaust distribution | Galvanized Steel | Low Pressure
Exhaust Air Distribution | Galvanized Steel | Medium Pressure

**Laboratory Exhaust Systems:**

General lab exhaust - air device to General Exhaust valve | Galvanized Steel | Low Pressure
General lab exhaust – General Exhaust valve to exhaust fan | Galvanized Steel | Medium Pressure
Lab exhaust – Hood/BSC to Lab Exhaust valve | 316L Stainless Steel | Medium Pressure
Lab exhaust – Lab Exhaust valve to exhaust fan | 316L Stainless Steel | Medium Pressure

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**B. Notes to Table:**

1. Positive pressure unless noted otherwise in Table.
2. From air handling unit (AHU) to terminal boxes.
3. From pretreatment AHU to AHU.
4. Runout from air device to return/exhaust air trunk duct
5. Negative pressure SMACNA table.
6. Applies to exhaust system for general laboratory exhaust, fume hoods, and biosafety cabinets. Refer to Drawings for construction of any additional exhaust systems.

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**2.3 DUCT MATERIAL AND CONSTRUCTION**

**A. General.** Noncombustible or conforming to requirements for Class I air duct materials or UL 181. All ductwork indicated on the Drawings, specified or required for the air conditioning and ventilating systems shall be of materials as hereinafter specified unless indicated otherwise on Drawings. All air distribution ductwork shall be fabricated, erected, supported, etc., in accordance with all applicable standards of SMACNA where such standards do not conflict with NFPA 90A and where class of construction equals or exceeds that noted herein.
B. Galvanized Steel Ducts. Constructed of G-60 coated galvanized steel meeting requirements of ASTM A 653 or ASTM A 527. Stencil coils of sheet steel throughout on 10 foot centers with gage and manufacturer's name. All materials associated with the duct system shall be galvanized steel including stiffeners, fasteners, etc.

C. Stainless Steel Ducts. Type 304 or 316L as indicated in application schedule. For round ductwork, butt-welded (solid welded) longitudinal seam only. Spiral lockseam and Spiral lockseam with standing rib is not acceptable.

D. Fasteners. Rivets, bolts or sheet metal screws.

E. Sealant.
   1. Sealant shall be water based, latex UL 181B-M sealant with flame spread of 0 and smoke developed of 0. Sealants shall be similar to Foster 32-19, Childers CP-146, Hard Cast Iron Grip 601, Ductmate Pro Seal or Design Polymerics DP 1010.
   2. Scrim tape shall be fiberglass open weave tape, 3 inches wide, with maximum 20/10 thread count.

F. Hangers and Supports.
   1. Support ductwork with continuously threaded hanger rods of galvanized steel or 20 gauge straps as indicated in these specifications.

2.4 RECTANGULAR DUCTS AND FITTINGS GENERAL REQUIREMENTS

A. General Fabrication Requirements: Comply with SMACNA based on indicated static-pressure class unless otherwise indicated. In no case shall the ductwork be less than 26 gage for low pressure ductwork, 24 gage for medium pressure ductwork.

B. Transverse Joints: Select joint types and fabricate according to SMACNA Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA. Snaplock longitudinal seams (L2) are not acceptable.

D. Fittings:
   1. Select types and fabricate according to SMACNA Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA.
   2. Construct bends and elbows per SMACNA Figure 2-2, "Rectangular Elbows", Type RE1 with radius of not less than 1-1/2 times width of duct on centerline. Where not possible or where indicated on construction documents, construct Type RE2 rectangular elbows with welded-in-place double wall airfoil turning vanes (whether specifically shown on drawings or not), or short radius type RE1 radius elbows.
   3. Construct tees per SMACNA Figure 2-5, "Divided Flow Branches", Type 2, Type 3, Type 4A or 4.
   4. Construct branch connections per SMACNA Figure 2-6, "Branch Connection". Use 45 degree entry, 45 degree lead in, conical or bellmouth connections only.
   5. Unless indicated on construction document details, transform duct sizes gradually, not exceeding 15 degrees divergence and 30 degrees convergence. Divergence upstream
of equipment shall not exceed 30 degrees. Convergence downstream of equipment shall not exceed 45 degrees.

6. Bullhead tees are not permitted.

2.5 ROUND AND OVAL DUCTS AND FITTINGS GENERAL REQUIREMENTS

A. General Fabrication Requirements: Comply with SMACNA Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated. In no case shall the ductwork be less than 26 gage.

B. Transverse Joints: Select joint types and fabricate according to SMACNA Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA. Use flanged joints for ducts larger than 48 inches in diameter.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA. Utilize spiral seam or butt weld seams only. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.

D. Fittings:
   1. Fittings shall have a wall thickness not less than that specified for longitudinal-seam straight duct or 26 gage, whichever is more stringent.
   2. Tees and Laterals: Select types and fabricate according to SMACNA Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA. Utilize 90 degree tee with oval to round tap, 45 degree lateral tap, or conical fitting only. Wye fittings may be utilized where specifically indicated on drawings and details.
   3. Elbows: Construct elbows with radius of not less than 1-1/2 times width of duct on centerline. Provide minimum 5 gore elbows on all 90 deg elbows, 3 gore elbows on 45 degree elbows. Continuously welded stamped long radius elbows may be utilized on ductwork up to and including 12-inches in diameter.
   4. Bullhead tees are not permitted.

2.6 INSULATED FLEXIBLE DUCTWORK

A. Use for connection to diffusers, grilles and terminal boxes as indicated in specifications and details.

B. Construct the inner liner of coated steel helix and a PE or CPE liner substantially bonded together to prevent the duct from collapsing or kinking in short radius bends. Provide fiberglass insulation providing minimum R-4.2 thermal conductance and 3 pound minimum density around inner jacket consisting of fiberglass reinforcement and aluminum foil vapor barrier outer jacket. Use duct rated at minimum working pressure of 10 inches of water positive and 1 inches of water maximum negative pressure (4-12 in I.D.), and 6 inches of water positive and 1/2 inch of water maximum negative pressure (14- 16 I.D.). Provide duct listed by U.L. at flame spread rate of not over 25 and smoke developed rate of not over 50, and complying with NFPA Standard 90A and 90B. The entire assembly shall be listed by Underwriters Laboratories under U.L. Standard 181 as a Class I flexible air duct. Supplier shall submit laboratory test results indicating acoustical performance comparable to that of "Flexmaster Type 1M-Insulated".
2.7 STAINLESS STEEL DUCTWORK (LAB EXHAUST)

A. Applies to stainless steel ductwork indicated in specification application table for Laboratory Exhaust Systems.

B. Provide a welded sample for approval to the engineer and Owner.

C. Provide exhaust ductwork of minimum gages:

<table>
<thead>
<tr>
<th>DUCT SIZE</th>
<th>GAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>28-inch diameter or less</td>
<td>18</td>
</tr>
<tr>
<td>30-inch to 60-inch diameter</td>
<td>16</td>
</tr>
<tr>
<td>61-inch diameter or greater</td>
<td>14</td>
</tr>
<tr>
<td>Greater than 60 x 42 (rectangular or oval)</td>
<td>Comply with SMACNA</td>
</tr>
</tbody>
</table>

D. ALL LAB EXHAUST DUCTWORK SHALL HAVE LONGITUDINAL BUTT (“SOLID”) WELD SEAMS WITH BUTT WELD JOINTS. Butt-weld all joints and fittings using Gas Tungsten Arc Welding (“TIG”). Welding procedures shall meet the requirements of SMACNA’s The Managers’ Guide for Welding. Welds on exposed ductwork inside the building shall be ground and polished. Duct sealant shall not be used to seal ductwork.

E. Provide required transitions from duct to equipment and make equipment connections as indicated on details.

F. Fittings:
   1. Refer to Round and Oval Ducts and Fittings General Requirements in this specification. Transverse and longitudinal seams shall be butt welded joints.
   2. Refer to drawings for additional information.

G. Submit upon request by owner or A/E, certification of welder’s qualifications to perform the required welding operations and all project WPS for TIG welding sheet metal. All welder certifications shall be maximum 2 years prior to project notice to proceed date.

2.8 INTERNAL ACOUSTIC DUCT LINING

A. Internal insulation with JohnsManville Permacote Linacoustic standard fiberglass duct liner with factory-applied edge coating. Insulation shall have a composite, abrasion resistant airstream surface with EPA-registered, anti-microbial coating that will not support microbial growth.

B. Duct Lining used on the project must have a flame spread rating not exceeding 25 and a smoke developed rating not exceeding 50 as determined by test procedures ASTM E 84, NFPA 255 and UL 723. These ratings must be as tested on the composite of insulation, jacket or facing, and adhesive. Components such as adhesives, mastics and cements must meet the same individual ratings as the minimum requirements. The liner shall meet the Life Safety Standards as established by NFPA 90A and 90B.

C. Provide insulation thicknesses as follows:
   1. Provide 1/2 inch insulation on all return air transfer ductwork as shown on detail.
   2. Provide 1 inch duct liner insulation in ductwork in the following locations:
      a. Exposed labs (no ceilings) on supply ductwork downstream of terminal units.
      b. Supply, return and exhaust duct sizes shown on drawings are clear inside sheet metal dimensions. Include proper allowances for acoustical lining.
PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Construction Standards. Use construction methods which follow the requirements outlined SMACNA publications, as well as SMACNA Balancing and Adjusting publications, unless indicated otherwise in these specifications or accompanying drawings.

B. Reinforcement. Reinforce ducts having one side equal to 25 inches or more in accordance with recommended construction practice of SMACNA.

C. Plenum Construction. Construct plenum chambers of not less than No. 20 U.S. gage metal reinforced with galvanized structural angles.

D. Cross Breaking or Beading. Cross break or bead sheet metal for rigidity, except ducts which are 12 inches or less in the longest dimension.

E. Wall and Floor Penetrations.
   1. Install fire, smoke and combination fire smoke dampers in floor penetrations and in one and two-hour rated walls where indicated in drawings and in accordance with Specification 23 3133.
   2. Where ducts pass through walls in exposed areas, install suitable escutcheons made of galvanized sheet metal angles as closers.
   3. At all locations where ductwork passes through floors, provide watertight sleeves projecting 3 inches above finished floor and flush with bottom of floor slab. Fabricate sleeves of 1/8 inch thick steel, galvanized after fabrication. Anchor into adjacent floor slab as required.
   4. Sleeves are required inside as well as outside chases.

F. Interior Painting. Interior painting of metal ductwork exposed to view through grilles, registers, and other openings is specified in the Section on painting. Do not install grilles, registers, or similar items until painting is complete.

G. Ductwork Openings. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

H. Ductwork Location. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities, including access to electrical and control panels.

I. Instrument Test Hole Fitting. Provide Duro Dyne Model TH-1 instrument test ports with heavy-duty zinc-plated heavy-gage cap, instant-release wing nut, neoprene expansion plug, flat neoprene mounting bracket and mounting holes. Provide fittings to air balance contractor.

J. Provide transitions at equipment and air device connections as per SMACNA standards. Where equipment requires an oval inlet and a round flex duct is routed to the equipment, provide insulated round to oval transition.

K. Install duct mounted electric and hot water coils, provided in other specification sections, if required.
L. Refer to mechanical details for information on terminal box connections, diffuser connections, fume hood connections, lab-trac equipment, etc.

3.2 SEAM AND JOINT SEALING

A. All duct systems (except welded exhaust ductwork and double wall flue) shall be sealed. Duct shall be thoroughly cleaned prior to application of sealant. All transverse joints, longitudinal seams and duct wall penetrations shall be sealed. All ductwork shall be sealed as per seal Class A of SMACNA Standards irrespective of the duct pressure classifications

3.3 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports." Unless indicated otherwise in specifications.

B. Hanger Spacing. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing. Install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection. Do not use wire to support ductwork.

C. Horizontal Ducts Up to 40 Inches. Support horizontal ducts up to and including 40 inches in their greater dimension by means of No. 20 U.S. gage band iron hangers attached to the ducts by means of screws, rivets or clamps, and fastened to inserts with toggle bolts, beam clamps or other approved means. Use clamps to fasten hangers to reinforcing on sealed ducts.

D. Horizontal Ducts Larger Than 40 Inches. Support horizontal ducts larger than 40 inches in their greatest dimension by means of hanger rods bolted to angle iron (or equivalent unistrut) trapeze hangers. Place supports on at least 8'-0" centers according to the following:

<table>
<thead>
<tr>
<th>Angle Length</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>

The trapeze is to be placed on the exterior of non-compressible insulation between hanger and ductwork.

E. Vertical Ducts. Support ducts to ensure rigid installation. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Fig. 4-7, Fig 4-8, Fig 4-9 "Riser Supports – From Floor". Support vertical ducts where they pass through the floor lines with 1-1/2 inches x 1-1/2 inches x 1/4 inch angles for ducts up to 60 inches. Above 60 inches, the angles must be increased in strength and sized on an individual basis considering space requirements. Support vertical duct drops more than 6 feet in length with angle iron frames attached to ducts.

F. Refer to drawings for additional hanger details and requirements. Note that not all hangers are shown on the drawings are in the BIM model. The Contractor shall coordinate all hangers with the structure and other trades.
3.4 FLEXIBLE DUCTWORK

A. Low Pressure Flexible Ductwork
1. Do not exceed 5 feet in length with any flexible duct.
2. Flexible duct shall be limited to a maximum of a single 90 degree change in direction between the duct and the neck of the air device. This does not include the final turn into the neck of the air device.
3. Support ductwork independently of lights, ceiling and piping. Provide harness at connection to ceiling diffuser as indicated on details.
4. Provide two nylon panduits or stainless steel work clamps on inner core and seal connection with duct sealant. The insulation and outer jacket shall be slipped over inner core connection to point where insulation abuts insulation on duct or diffuser. The insulation connections shall be sealed by embedding scrim tape and sealant to form a vapor barrier.

B. Medium Pressure Flexible Ductwork
1. Refer to details for maximum length of flexible ductwork upstream of terminal box.
2. Do not use flexible ductwork for changes in direction of airflow.
3. Provide two stainless steel work clamps on inner core and seal connection with duct sealant. The insulation and outer jacket shall be slipped over inner core connection to point where insulation abuts insulation on duct or terminal box. The insulation connections shall be sealed by embedding scrim tape and sealant to form a vapor barrier.

3.5 LABORATORY EXHAUST DUCTWORK

A. Butt-weld all joints and fittings using Gas Tungsten Arc Welding (“TIG”) as indicated in Part 2. Welding procedures shall meet the requirements of SMACNA’s The Managers’ Guide for Welding. The welder shall be experienced and qualified with TIG welding. Prior to welding joints are fittings, the ductwork shall be free of rust, oil, paint or other foreign materials.

B. Install ducts with an upward grade in the direction of flow. Make the grade a minimum of 1/8 inch per foot. Low places in the duct that can collect moisture will not be allowed. Use eccentric reducers, with the flat on bottom, in ductwork to maintain slope.

C. All welds shall be cleaned with uncontaminated stainless steel wire brush prior to inspection. Welds shall be visually inspected and meet the requirements of AWS D9.1 and SMACNA’s The Managers’ Guide for Welding.

3.6 FLASHING

A. Where ducts pass through roofs or exterior walls, provide suitable flashing to prevent rain or air currents from entering the building. Provide flashing not less than No. 26 gage stainless steel or 16 ounce copper.

3.7 DUCT LINING

A. Install per manufacturer’s recommendations. Keep internal lining clean during construction by keeping ends of ductwork sealed during storage and construction.
3.8 TESTS

A. Allowable Leakage. Test ductwork for leaks in accordance with SMACNA testing procedures before concealing or insulating as indicated below. Arrange for the Owner's Representative to witness the test.

1. Low pressure ductwork. Test low pressure ductwork at +2 inches W.G. Maximum allowable leakage (Lmax) per 100 ft² of ductwork shall be equal to \( C_L \times P^{0.65} \), where \( C_L = 4 \) for rectangular ducts and round flexible ducts, \( C_L = 3 \) for round/flat oval ducts, and \( P = 2'' \) for low pressure ducts.

2. Medium pressure ductwork. Test medium pressure ductwork at +6 inches W.G. Maximum allowable leakage (Lmax) per 100 ft² of ductwork shall be equal to \( C_L \times P^{0.65} \), where \( C_L = 4 \) for rectangular ducts and round flexible ducts, \( C_L = 3 \) for round/flat oval ducts, and \( P = 6'' \) for medium pressure ducts.

3. Lab exhaust ductwork. Test laboratory exhaust ductwork at +6 inches w.g. Maximum allowable leakage is 1/2% of the total system air flow rate. Where partial sections of the duct system are tested, the summation of the leakage for all sections shall not exceed the total allowable leakage.

4. Test the following ductwork:
   a. Low pressure ductwork:
      1) All ductwork served by terminal boxes.
   b. Medium pressure ductwork:
      1) All ductwork served by individual air handling units.
      2) All ductwork served by exhaust fans.
   c. Other
      1) Do not test Double Wall Flue Piping or Dryer Exhaust Ductwork.

B. Equipment. Provide equipment necessary for performing tests, including rotary blower, orifice section and U-tube gage board complete with cocks and rubber tubing.

3.9 CLEANING

A. Protect all ductwork and equipment from dirt during storage, installation and prior to grille, diffuser installation with protective covering at each end. Ductwork exposed to dirt and dust due to inadequate protection will have to be removed, cleaned and reinstalled.

B. Do not operate any air handling units or fan coil units during construction without filters.

C. Provide temporary filters on return air ductwork during construction to protect ductwork from dust.

D. Provide temporary filters on exhaust grilles during construction to protect ductwork from dust.

E. Do not operate laboratory exhaust fans during any drywall operation to protect ductwork, hoods and laboratory control products.

END OF SECTION
SECTION 23 3300
AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fire dampers.
   2. Volume control dampers.
   3. Duct access doors.
   4. Conical spin-in fittings and taps
   5. Duct accessory hardware.
   6. Flexible Connection
   7. Laboratory exhaust accessories

1.2 RELATED WORK

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

B. Specification 23 3113, Ductwork

1.3 SUBMITTALS

A. Product Data: Submit product data for each product. Refer to Section 23 0010.

B. Fire and Combination Fire/Smoke Damper. Include manufacturer’s literature to include
   performance data and installation requirements. Include any wiring diagrams. Installation shall
   clearly indicate
   1. Proposed break-away connections used on the project.
   2. Clearance requirements between wall/floor and damper.
   3. Mounting/Retaining locations, size, gauge and fastener requirements.

C. Access Doors. Include type of material, installation guidelines, leakage rates and maximum
   pressure data.

D. Volume Control Dampers. Include type of material, installation guidelines, pressure drop and
   maximum pressure data.

E. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and
   attachments to other work.
   1. Detail duct accessories fabrication and installation in ducts and other construction.
      Include dimensions, weights, loads, and required clearances; and method of field
      assembly into duct systems and other construction. Include the following:
      a. Special fittings.
      c. Control damper installations.
d. Fire-damper and smoke-damper installations, including sleeves; and duct-mounted access doors. Provide break-away duct/sleeve connection detail.
e. Wiring Diagrams: For power, signal, and control wiring.

1.4 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 23 0010.

B. Fire dampers, smoke dampers and combination fire/smoke dampers.
   1. Include operation and maintenance information, including recommended testing requirements.
   2. Assign identification numbers (FD – Fire Damper, FSD – Fire/smoke Damper, SD – Smoke Damper) for each damper. Include table in O&M manual that indicates identification number, room location, duct system and size.

1.5 QUALITY ASSURANCE

A. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references
   2. AMCA 500-D, “Laboratory Method of Testing Dampers for Rating”
   4. SMACNA - HVAC Duct Construction Standards Metal and Flexible – Second Edition
   5. UL 555 – Standard for Fire Dampers.
   7. UL 555S – Standard for Smoke Dampers

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Fire, Smoke and Fire/Smoke Dampers. Greenheck, Pottorff, Ruskin.


C. Duct Access Doors. Ductmate, Flexmaster, Greenheck, Ruskin, United McGill.

D. Conical Spin-in Fittings. Flexmaster, Buckley

E. Volume Control Dampers. Flexmaster, Greenheck, Prefco, Ruskin.

2.2 MATERIALS

A. Comply with SMACNA’s "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated.
B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G60.
   2. Exposed-Surface Finish: Mill phosphatized.

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316L, and having a No. 2 finish for concealed ducts and finish for exposed ducts.

D. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

2.3 FIRE DAMPERS (FD)

A. Quality Standards. Furnish and construct fire dampers according to NFPA 90A and UL 555 (Dynamic). Dampers must bear UL label and suitable for dynamic application. Dampers shall possess a 1-1/2 hour or 3 hour (as appropriate for the construction shown in the architectural Drawings) protection rating 165 degrees F fusible link.

B. Construct fire dampers such that damper frame material and curtain material are galvanized.

C. Use Curtain Type Fire Dampers for fire dampers where possible. Use Multiple Blade Fire Dampers for fire damper sizes that exceed manufacturer’s allowable Curtain Type Fire Damper sizes, or where velocities or pressures exceed Curtain Type Fire Dampers.

D. Curtain Type Fire Dampers (Type B)
   1. Damper shall be classified for dynamic closure to 2000 fpm and 4 inches w.g. static pressure.
   2. Damper shall have 5” frame constructed from minimum 22 gage galvanized steel.
   3. Blades shall be minimum 24 gage galvanized steel.
   4. Closure springs shall be Type 301 stainless steel, constant force or spring clip type.
   5. Provide Grille, Grille Access Type or Out of Wall Type of frame where indicated on drawings.

E. Multiple Blade Fire Damper
   1. Dampers shall be suitable for dynamic closure to 3000 fpm and 6 inches w.g. static pressure at 90”x64” for vertical installation and 60”x48” for horizontal installation.
   2. Damper shall have 5” frame constructed from minimum 16 gage galvanized steel channel and reinforced at the corners.
   3. Blades shall be 6” wide airfoil type and constructed from minimum 14 gage galvanized steel.
   4. Bearings shall be self-lubricating stainless steel sleeve, turning in extruded hole in frame.
   5. Blade seals shall be galvanized steel for flame seal to 1,900 degrees F and mechanically attached to blade edge.
   6. Linkage shall be concealed in frame.
   7. Provide ½-inch diameter plated steel hex shaped axle attached to blade.
   8. Pressure drop shall be a maximum of 0.07 inches w.g. at 1,500 feet per minute through 24 x 24 inch damper.
2.4 COMBINATION FIRE AND SMOKE DAMPERS (FSD)

A. Quality Standards. Furnish and construct combination fire/smoke dampers according to NFPA 90A and UL 555 (Dynamic). Dampers must bear UL label and suitable for dynamic application and a Leakage Class 1 Smoke Rating in accordance with UL 555S. Dampers shall possess a 1-1/2 hour or 3 hour (as appropriate for the construction shown in the architectural Drawings) protection rating 165 degrees F. Dampers shall have a minimum 5 year warranty.

1. Dampers shall be suitable for dynamic closure to 3000 fpm and 6 inches w.g. static pressure at 120"x96" for vertical installation and 144"x96" for horizontal installation.
2. Damper shall have 5” frame constructed from minimum 16 gage galvanized steel channel and reinforced at the corners.
3. Blades shall be 6” wide airfoil type and constructed from minimum 14 gage (equivalent) galvanized steel.
4. Bearings shall be self-lubricating stainless steel sleeve, turning in extruded hole in frame.
5. Blade seals shall be inflatable silicone fiberglass material, rated for maintaining smoke leakage at a minimum of 450°F and galvanized steel for flame seal to 1,900 degrees F. Seals shall be mechanically attached to blade edge. Provide stainless steel flexible metal compression jamb.
6. Linkage shall be concealed in frame.
7. Provide ½-inch diameter plated steel hex shaped axle attached to blade.
8. Temperature Release Device. Close in a controlled manner and lock damper during test, smoke detection, power failure, or fire conditions through actuator closure spring. At no time shall actuator disengage from damper blades. Allow damper to be automatically and remotely reset after test or power failure conditions. After exposure to high temperature or fire, inspect damper before reset to ensure proper operation. Controlled closing and locking of damper in 7 to 15 seconds to allow duct pressure to equalize. Instantaneous closure is not acceptable.
9. Actuator. Provide electric 120V [24V], 60 Hz, two-position, fail close actuator. Operators shall be UL listed and labeled.
10. Pressure drop shall be a maximum of 0.07 inches w.g. at 2,000 feet per minute through 24 x 24 inch damper.

2.5 VOLUME CONTROL DAMPERS

A. Provide volume dampers in round and rectangular ductwork where indicated on drawings.

B. General Fabrication Requirements:

1. Comply with SMACNA Chapter 2, "Volume Dampers" unless more stringent requirements are indicated. Provide single blade dampers on round dampers and for rectangular dampers not exceeding 36-inches in width or 12-inches in height. Provide multiblade rectangular dampers for dampers exceeding 36-inches in width or 12-inches in height or where required due to velocity or pressure requirements.
2. Refer to Specification 23 31 13 Ductwork for application table that defines Low and Medium Pressure ductwork.
3. Provide a locking hand quadrant on all dampers. Mount quadrant regulators on stand-off mounting brackets, bases, or adapters on insulated ducts. Quadrant handle shall have infinite adjustable positions between open and closed.
4. For stainless steel ductwork, provide stainless steel finish to match ductwork material.

C. Round Dampers.

1. Low Pressure. Provide single blade damper with minimum 20 gage galvanized steel frame, minimum 20 gage galvanized steel blade, continuous 3/8” square plated steel axle mechanically attached to blade, and bronze or oilite bearings. Dampers shall be suitable for 1500 feet per minute velocity and a maximum pressure of 2”W.G. when closed, and a
maximum pressure drop of 0.03"W.G at 1500 feet per minute through a 20-inch damper when tested in accordance with AMCA Fig. 5.3.

2. Medium Pressure. Provide single blade damper with minimum 20 gage galvanized steel frame, minimum 14 gage (equivalent) galvanized steel blade, continuous 1/2" square plated steel axle mechanically attached to blade, and bronze or oilite bearings. Dampers shall be suitable for 3000 feet per minute velocity and a maximum pressure of 4"W.G. when closed, and a maximum pressure drop of 0.06"W.G at 2000 feet per minute through a 24-inch damper when tested in accordance with AMCA Fig. 5.3.

D. Rectangular Dampers.
   1. Low Pressure Single Blade Damper (Fans systems with less than 1"W.G. Static Pressure). Provide single blade damper with minimum 3-inch x 20 gage galvanized steel frame, minimum 20 gage galvanized steel blade on dampers up to 18-inches wide, 16 gage on dampers over 18-inches wide. Provide a continuous 3/8" square plated steel axle mechanically attached to blade, and synthetic flanged sleeve type bearing. Dampers shall be suitable for 1500 feet per minute velocity and a maximum pressure of 1"W.G. when closed.
   2. Low Pressure Multi-Blade Damper. Provide opposed multi-blade damper with minimum 5-inch x 16 gage galvanized steel frame, minimum 16 gage triple V galvanized steel blade. Provide a continuous 1/2" square plated steel axle mechanically attached to blade and external (out of airstream) blade-to-blade linkage. Provide bronze or oilite bearings. Dampers shall be suitable for 1500 feet per minute velocity and a maximum pressure of 3"W.G. for up to a 24-inch wide damper when closed. Damper shall have a maximum pressure drop of 0.1"W.G. at 1500 feet per minute through a 24-inch x 24-inch damper.
   3. Medium Pressure Damper. Provide opposed multi-blade damper with minimum 5-inch x 1-inch 16 gage galvanized steel channel frame. Blades shall be minimum 16 gage triple V galvanized steel blade. Provide a continuous 1/2" square plated steel axle mechanically attached to blade and external (out of airstream) blade-to-blade linkage. Provide bronze or oilite bearings. Dampers shall be suitable for 3000 feet per minute velocity and a maximum pressure of 5"W.G. for up to a 24-inch wide damper when closed. Damper shall have a maximum pressure drop of 0.16"W.G. at 2000 feet per minute through a 24-inch x 24-inch damper when tested in accordance with AMCA Fig. 5.3.

2.6 DUCT ACCESS DOORS

A. Square Frame Access Doors
   1. Low Pressure Ductwork
      a. Construct outer frame of minimum 22 gage roll formed galvanized steel with installation tabs. Door shall be removable double wall door constructed of 24 gage galvanized steel and insulated with 1-inch of insulation (R-4). Provide minimum 2 manually operated cam locks on access doors 16-inches and under, 4 cam locks for doors greater than 16-inches. Provide foam gasket seal between door and frame and between frame and duct.
      b. Performance. 24"x24" access door shall be suitable for up to 2"W.G. and have a maximum leakage of 0.15 CFM/sq.ft. at 1"W.G. pressure.
   2. Medium Pressure Ductwork
      a. Construct outer frame of minimum 22 gage roll formed galvanized steel with installation tabs. Door shall be removable double wall door constructed of 24 gage galvanized steel and insulated with 1-inch of insulation (R-4). Provide minimum 4 manually operated cam locks on access doors 16-inches and under, 8 cam locks for doors greater than 16-inches. Provide foam gasket seal between door and frame and between frame and duct.
b. Performance. 24”x24” access door shall be suitable for up to 10”W.G. and have a maximum leakage of 0.15 CFM/sq.ft. at 1”W.G. pressure.

B. Round “Spin” Access Doors
   1. Construct outer frame of minimum 22 gage roll formed, double hemmed galvanized steel. Door shall be revovable double wall door constructed of 24 gage galvanized steel and insulated with 1-inch of insulation (R-4). Provide minimum 3 manually operated cam locks on access door. Provide continuous foam gasket between door and frame.

C. For stainless steel ductwork, provide stainless steel finish to match ductwork material.

D. Where duct size permits, access door size shall be 18-inches in diameter or 18” x 16” for oval and rectangular doors. For duct sizes under 20-inches, provide access door 2-inches smaller than duct size. For ducts 12-inches wide, provide minimum 10” x 12”.

2.7 CONICAL SPIN-IN FITTINGS AND TAPS

A. General Construction. For stainless steel ductwork, provide stainless steel finish to match ductwork material.

B. Furnish conical spin-in fittings with quadrant dampers at all round runout ducts serving diffusers and grilles. Fabricate conical fitting of 26-gage galvanized sheet metal with 2-inch build out, continuous 3/8” square shaft, air tight nylon bushings and locking quadrant handle. Connect damper plate to shaft with a minimum 2 u-bolts on dampers 12-inches and greater. Quadrant handle and damper shall have infinite adjustable positions between open and closed.

2.8 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Drill temporary test holes for balancing in ducts as required. Cap with neoprene plugs, threaded plugs, or threaded or twist-on metal caps. Provide neat patch on external duct insulation and label as “Test Plug”.

C. Provide permanent test holes in ductwork upstream and downstream of all coils, fans, and locations as indicated on drawings. Test holes shall be factory fabricated, airtight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.9 FLEXIBLE CONNECTIONS

A. Provide air-tight flexible connections where ductwork connects to fans, air handling units and fan coil units with fabric as specified below:

<table>
<thead>
<tr>
<th>Application</th>
<th>Fabric</th>
<th>Coating</th>
<th>Gauge</th>
</tr>
</thead>
<tbody>
<tr>
<td>HVAC (Indoor)</td>
<td>Fiberglass</td>
<td>Neoprene</td>
<td>28</td>
</tr>
<tr>
<td>HVAC (Outdoor &amp; Lab)</td>
<td>Fiberglass</td>
<td>Hypalon</td>
<td>28</td>
</tr>
</tbody>
</table>

B. The fabric shall be UL listed, fire retardant, waterproof and mildew resistant, crimped into metal edging strip.
2.10 LABORATORY EXHAUST ACCESSORIES

A. Low-Leakage Isolation Damper (Gas Tight Dampers for Type IIB2 Hoods)
   1. Acceptable Manufactures
      a. NuAire
      b. Greenheck
      c. Flanders
      d. Ruskin
   2. Dampers shall be a gas tight, positive seal, isolation type shall not exceed a leakage rate of 0.029 cfm/inch of circumference of blade at 10 inches water gage. The design pressure of the damper shall be 10 inch water gage. Damper housings shall be cylindrical and constructed of 10 ga., T-304 stainless steel. Blade shall consist of two 10 ga. T-304 stainless steel plates with a closed cell neoprene rubber gasket between them. Blade seal shall occur when the neoprene gasket seats against the inside of the 10 ga. housing wall. The damper shall be all weld design. All "pressure retaining" weld joints and seams shall be continuously welded" weld joints and seams requiring only intermittent welds by design shall not be continuously welded. As a minimum, all weld joints and seams shall be wire brushed and/or buffed to remove heat discoloration, burrs and sharp edges. All welding procedures, welders, and welder operators shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX.
   3. Flanges: Minimum of 1-1/2" wide. Factory drilled bolt holes (7/16' diameter) shall be no more than 4" apart as recommended in ERDA 76-21, "Nuclear Air Cleaning Handbook."
   4. Frame: 10 ga. (min) T-304 stainless steel (unpainted).
   5. Shaft & Linkage Components: All components of the blade are manufactured from 300 Series stainless steel. Shafts are 1/4" diameter (mm.) stainless steel rod with shaft seals.
   7. Damper shall be manufactured under a quality assurance program that addresses the requirements of ANSI/ASME NQA-1, "Quality Assurance Program Requirements for Nuclear Facilities." All production welds shall be visually inspected per CSC's standard procedure number P-122, "Visual Inspection of Welds," which incorporates the workmanship acceptance criteria described in Section 4 and 5 of AWS D9 1, "Specification for Welding of Sheet Metal." The damper blade shall be tested in the ANSI/ASME N-510-1980, "Testing of Nuclear Air Cleaning Systems." Blade shall not exceed a leakage rate of 0.029 cfm/inch of circumference of blade. The complete pressure boundary (damper housing) shall be tested same as the blade, except the maximum leak rate shall be 0.005 cfm/sq.ft. of housing surface.
   8. Dampers shall be equal to NuAire Model NU940.

B. C.A.T.S. E-Z Joint Connector. Provide Type 316L stainless steel round duct joint connector for connection of ductwork at lab exhaust valve as indicated in drawing details. Product shall be manufactured by Standard Sheet Metal Works. System shall consist of ½" flanged end duct connectors meeting requirements of SMACNA, and suitable up to 30"W.G. positive/negative pressure. System shall include Nitril/PVC blend gasketing.

C. Fernco Fitting. Provide Fernco coupling at fume hood connection as indicated in drawing details. Coupling shall resistant to UV and conform to ASTM D5926. Provide two stainless steel clamps for connection to ductwork. Coupling shall be suitable for temperatures between -30°F and 140°F and pressures up 4.3 psig.
D. Air Pressure Stabilizer
   1. Acceptable Manufacturer
      a. Apreco
      b. Aercon
   2. Provide air pressure stabilizer designed to control the differential air pressure between adjacent rooms, with blades opening/closing based upon the pressure indicated on the schedule. Stabilizer shall include the following:
      a. Flanges shall fit standard wall thickness range of 4-inches to 7-inches. Provide extension for deeper walls.
      b. Removable blades for maintenance and cleaning.
      c. Aluminum frame with carbon steel blades. All components shall be powered coated.
      d. Stainless steel ball roller type ball bearings that are sealed for life.
      e. Pressure control range shall be between 0.01”W.C and 0.2”W.C. Damper shall be factory set based upon scheduled value and have the ability for onsite adjustment.
   3. Options
      a. Light Shield. Provide a light reduction assembly construction of an aluminum enclosure with internal light absorbing/deflection blades. Assembly shall be powder coated. Unit shall have maximum 6-inches of depth regardless of damper size.
      b. Volume Adjustment Arms. Provide volume adjustment arms that restricts the opening of the blades.
      c. Fly Screen. Provide a fine mesh designed for fly and pest control, 0.05” x 0.05” mesh, 73% free area.
      d. Perforated Screen. Provide a perforated screen with 1/8” diameter openings and minimum 50% free area.

E. Thermofit Wraparound Duct Band (TWDB)
   1. Acceptable Manufacturer
      a. Covalence (formerly Raychem)
   2. Provide TWDB heat-shrinkable duct joint sealing tape where indicated on details. The joint sealing tape/band shall be constructed of two layers. The first layer shall be a copolymer adhesive and the second layer shall be a thick-walled radiation-crossed-linked high density polyethylene. TWDB shall be suitable for up to 158 deg F temperature and require no priming of the duct system.
   3. Product Properties
      a. Tensile strength: 3300 psi (minimum)
      b. Shrink force: 40 psi (minimum)
      c. Water absorption: 0.05% maximum per ASTM D-570.
      d. Shear strength: 750 psi maximum per ASTMD-1002.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards,“ for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
   1. Install steel volume dampers in steel ducts.
   2. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

3.2 ACCESS DOORS

A. Install duct access doors on sides or bottom of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. Upstream and downstream of duct mounted duct coils.
   2. Downstream of control dampers.
   4. Adjacent to and close enough to fire, smoke and combination fire/smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors; and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers. Where size if the ductwork permits, provide minimum 18”x16” size access door.
   5. At duct mounted smoke detectors.
   6. In internally lined ductwork, provide access doors for duct liner inspection at 50 foot intervals and downstream of each elbow or branch fitting. Access doors are not required in return air boots.
   7. Elsewhere as indicated on drawings, details or specifications.

B. Label access doors according to Section 23 0553, Identification for HVAC Piping and Equipment to indicate the purpose of access door.

3.3 FIRE, SMOKE AND COMBINATION FIRE/SMOKE DAMPERS

A. Install dampers at locations indicated on the drawings and in accordance with manufacturer's UL approved installation instructions.

B. Install dampers square and free from racking with blades running horizontally.

C. Do not compress or stretch damper frame into duct or opening.

D. Handle damper using sleeve or frame. Do not lift damper using blades, actuator, or jackshaft.

E. Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.

F. Provide access doors for all fire, smoke and combination fire/smoke dampers. Refer to details for additional requirements.
3.4 CONICAL SPIN-IN FITTINGS AND TAPS

A. Install conical spin-in fittings with quadrant dampers to serve diffusers as indicated on drawings.

B. After installation of spin-in fitting, seal all around connection to meet leakage class indicated in Specification 23 3113.

3.5 VOLUME CONTROL DAMPER

A. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

B. Set dampers to fully open position before testing, adjusting, and balancing

3.6 FLEXIBLE CONNECTIONS

A. Install at connections between ductwork and motor driven equipment as shown. Provide a minimum of 1 inch slack in the connections, and a minimum of 2-1/2 inches distance between the edges of the ducts and equipment. Also provide a minimum of 1 inch slack for each inch of static pressure on the fan system. Securely fasten flexible connections to equipment and to adjacent ductwork by means of sealant with sheet metal screws. Where flex ductwork is connected to oval collars in diffusers and plenums, provide a metal transition fitting from oval to round.

3.7 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Operate all volume dampers to verify full range of movement.
   2. Inspect locations of access doors and verify that purpose of access door can be performed.
   3. Operate fire, smoke and combination fire/smoke dampers to verify full range of movement per NFPA and verify that proper heat-response device is installed.

END OF SECTION
SECTION 23 3713

AIR DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes air distribution devices including the following:
   1. Diffusers.
   2. Grilles.
   3. Registers.

1.2 COOPERATION WITH OTHER TRADES

A. Coordinate work with Division 26 Electrical Sections to ensure intended functions of lighting and air systems are achieved.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated, include the following:
   1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
   2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Samples: At the request of the Owner and/or A/E team, submit each exposed product for each color and texture specified.

C. Sound Attenuators. Submit schedule for each sound attenuator indicating size, airflow and static pressure. Submit product data indicating materials, acoustical performance and options provided that clearly indicate compliance with Part 2 of this Section. For all sound attenuators, provide documents proving that the acoustical performance as submitted has been certified by an independent laboratory in accordance with ASTM Specification E477-2013.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products meeting all requirements of this specification Section of the following manufacturers are acceptable:

2.2 DIFFUSERS

A. Square Plaque Diffuser (MARK A, P):
1. Provide aluminum plaque diffuser, precision formed back cone of one piece seamless construction which incorporates a round inlet collar of sufficient length for connecting rigid or flexible duct. An inner plaque assembly shall be incorporated that drops no more than 1/4 inch below the ceiling plane to assure proper air distribution performance. The inner plaque assembly shall be completely removable from the diffuser face to allow full access to any dampers or other ductwork components located near the diffuser neck.
2. Finish shall be White Powder Coat.
3. Provide transitions for rectangular duct connections if required.

B. Perforated Return/Exhaust (MARK C, CC, D, DD, R, RR, S, SS, TT):
   1. Provide steel frame construction with aluminum perforated face and white factory finish.
   2. Frame the diffuser face with a mitered and welded frame.
   3. Face shall have no less than 51% free area.
   3. Provide curved blade air deflector modules located in the neck of the diffuser.

2.3 GRILLES

A. Supply (MARK ES):
   1. Use double-deflection supply grilles made of aluminum.
   2. Install vertical face blades and horizontal rear blades. Provide solid, extruded aluminum blades which are individually adjustable. Space at not more than 3/4 inch centers for rear blades and 1/2 inch centers for face blades and not less than 5/8 inch deep.
   3. Employ grille frames of extruded aluminum with welded and mitered corners and mounting gaskets.
   4. Provide white finish on all grilles unless indicated otherwise on drawings.

B. Return and Exhaust (MARK ER, EE):
   1. For ceiling return, provide scheduled diffuser with white factory finish. Use construction and frame styles as specified for ceiling diffusers, but without pattern controllers. Use neck sizes as shown.
   2. For wall return and exhaust, provide a 45 degree fixed-blade aluminum grille. Provide 3/4 inch blade spacing as scheduled, with front blades parallel to long dimension. Provide solid, extruded frames and aluminum blades which are individually adjustable on sizes larger than 24 inches x 24 inches, roll-formed aluminum blades for smaller grilles. Include mounting gaskets. Provide white finish unless noted otherwise on drawings.

2.4 ACCESSORIES

A. Mounting Frames. Provide each grille or register not equipped with a removable core with a companion, all-purpose mounting frame constructed like a grille frame to facilitate installation and removal of the grille or register without marring adjacent mounting surfaces.
   1. Furnish frames with 1/2 inch thick sponge rubber gasket to prevent air leakage.
   2. Provide a frame that neatly fits the grille. Mounting frames will not be required for grilles or registers mounted directly on exposed ductwork.

2.5 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."
PART 3 - EXECUTION

3.1 INSTALLATION

A. Do not install ceilings adjacent to fixtures until installation of fixtures, air supply assemblies, return-air blank-off strips and flexible duct have been properly approved. Remove and reinstall any part of the installation found incorrect.

B. Diffusers. Louvered diffuser outlets mount tight against the ceiling. Fasten outlets securely to ductwork with sheet metal screws. For perforated diffusers, attach the frame assembly by a concealed hinge assembly to an outer frame compatible with the type of ceiling on which the diffuser is installed.

3.2 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION
SECTION 26 0000

ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials and equipment required for complete and functioning electrical systems as required by the contract documents.

B. New Work. The work includes, but is not limited to, the following principal systems and equipment:
   1. 208/120 volt distribution.
   2. Panelboards-Distribution, Branch Circuit and Electronic Grade.
   3. Transformers-General purpose, K-factor, and Harmonic Cancelling.
   4. Luminaires, poles, lamps and ballasts.
   5. Fire alarm system.
   6. Lighting controls.
   7. Digital addressable lighting control system.
   8. Grounding and bonding system.
   10. Variable frequency drives for AC electric motors. Furnished by Division 23, installed by Division 26.

C. Empty Raceway. Refer to Division 27 telephone/data and Division 28 security specifications for cabling requirements. Provide empty raceway for the following systems per ANSI/TIA-569-C:
   1. Communications: Computer system cables and outlets. Refer to telecommunications Drawings for additional work.
   2. Communications: Telephone system cables and outlets. Refer to telecommunications Drawings from additional work.

D. Demolition. Refer to demolition Drawings and Section 26 0001 for scope of work.

1.2 APPLICABLE PROVISIONS

A. Provisions Specified Elsewhere. Unless modified in this Section, General and Supplementary General Conditions, applicable provisions of Division 01 - General and other provisions of contract documents apply to work of Division 26 - Electrical.

B. Application. Provisions of this Section apply to every section of Division 26 - Electrical, except where specifically modified.

C. Work covered by this Section shall be accomplished in accordance with applicable provisions of the Contract Documents and addenda or directives which may be issued herewith, or otherwise.
1.3 RELATED WORK

A. Existing Conditions - Division 02.
B. Site Work – Division 02.
C. Concrete - Division 03.
D. Sealing and Firestopping – Division 07.
E. Openings - Division 08.
F. Finishes - Division 09.
G. Equipment - Division 11.
H. Furnishings – Division 12.
I. Special Construction – Division 13.
L. Plumbing – Division 22.
M. Heating, Ventilation and Air Conditioning – Division 23.
N. Communications – Division 27.
P. Utilities – Division 33.

1.4 REFERENCE CODES AND STANDARDS

A. Standards of the following organizations may be referenced in the specification. Unless noted otherwise, references are to standards or codes current at the time of bidding.
B. Association of Edison Illuminating Companies (AEIC).
C. American National Standards Institute (ANSI).
D. Institute of Electrical and Electronics Engineers (IEEE).
E. Insulated Cable Engineers Association (ICEA).
F. National Electrical Code (NEC).
G. Denton Electrical Code
H. National Electrical Manufacturers Association (NEMA).


K. Underwriters’ Laboratories (UL).


1.5 REGULATIONS AND PERMITS

A. Regulations. Work, materials and equipment must comply with the latest rules and regulations of the following:
   4. Occupational Safety and Health Act (OSHA).
   5. Americans with Disabilities Act (ADA).
   6. Texas Department of Licensing and Regulation (TDLR).
   8. Texas Electrical Safety and Licensing Act – Title 8, Occupations Code Chapter 1305.
   9. State and federal codes, ordinances and regulations.

B. Discrepancies. The drawings and specifications are intended to comply with listed codes, ordinances, regulations and standards. Where discrepancies occur, immediately notify the Owner’s representative in writing, including a proposed resolution, and ask for an interpretation. Should installed materials or workmanship fail to comply, the Contractor is responsible for correcting the improper installation. Additionally, where sizes, capacities, or other such features are required in excess of minimum code or standards requirements, provide those specified or shown.

C. Permits: Obtain certificates of inspection and other permits required as a part of the work. Submit written evidence to the Owner’s Representative and Architect/Engineer that the required permits and inspections have been secured.

1.6 DRAWINGS AND CONTRACT DOCUMENTS

A. Intent: The intent of the construction Drawings or contract documents, hereinafter referred to as the “Drawings”, is to establish the types of systems and functions, but not to set forth each item essential to the functioning of the system. The Drawings, specifications, and related contract documents are cooperative, and work or materials called for in one and not mentioned in the other shall be provided. Electrical Drawings, are generally diagrammatic and show approximate location and extent of the work. Review pertinent Drawings and adjust the work to conditions shown. Install the work complete, including minor details necessary to perform the function indicated.

B. The Contractor shall carefully investigate structural and finish conditions, and shall coordinate the work in order to avoid interference between the various phases of work. The Contractor shall be responsible for the proper routing of raceways, subject to prior review by the Owner’s Representative. Work shall be organized and laid out in finished portions of the building so that it will be concealed in furred chases, suspended ceilings, and similar elements of the building, unless specifically noted to be exposed. Work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.
C. Discrepancies: In case of doubt as to work intended, or if amplification or clarification is needed, or where discrepancies occur between Drawings, specifications, and actual field conditions, immediately notify the Architect/Engineer and the Owner’s Representative in writing, requesting an interpretation, and include a proposed solution.

D. Dimensions: Dimensional information related to new structures shall be taken from the appropriate Drawings. Dimensional information related to existing facilities shall be taken from actual measurements made by the Contractor on the site.

E. Outlet and Equipment Locations: Coordinate the actual locations of electrical outlets and equipment with building features and equipment as indicated on architectural, structural, mechanical, telecommunications, audio-visual (AV), security, plumbing, and laboratory Drawings. Review with the Owner’s Representative proposed changes in outlet and equipment location. Relocation of outlets before installation of up to 5 feet from the position indicated may be directed without additional cost to the Owner. Remove and replace outlets placed in unsuitable locations, when so requested by the Owner’s Representative, and at no additional cost to Owner.

1.7 SUBMITTALS

A. Submit the following in addition to and in accordance with the requirements of the Uniform General Conditions and in Division 01, Submittals.
   1. Include inspection and permit certificates and certificates of final inspection and acceptance from the authority having jurisdiction.
   2. Manufacturer’s standardized schematic diagrams and catalog cuts shall not be acceptable unless applicable portions are clearly indicated and non-applicable portions clearly deleted or crossed out.
   3. Schematic, connection and/or interconnection diagrams.
   4. Provide submittals as required by individual specification section.

B. Provide the following with each submittal:
   1. Catalog cutsheets with manufacturer’s name clearly indicated. Applicable portions shall be clearly indicated by arrows, circles, or similar markings and non-applicable portions shall be clearly deleted or crossed out.
   2. Line-by-line specification review by equipment manufacturer and contractor with exceptions explicitly defined.
   3. Itemize and organize equipment and material submittals by specification Section number; include manufacturer and identifying model or catalog numbers.
      a. Submittal packages for product data, shop drawings, and other required submittals shall be numbered sequentially according to the applicable specification Section number. For example, the first submittal package for Energy-Efficient Dry-Type Transformers shall be identified as Submittal number 262213-01. The second submittal package for Energy-Efficient Dry-Type Transformers would be identified as Submittal number 262213-02. Re-submittal packages shall be identified by an “R” in the sequential numerical suffix.
      b. Where directed by the Owner or the Architect to combine submittals into a common package, the submittal data may be organized in one or more 3-ring binders or similar container. Product data, shop drawings, and other submittal data shall be organized in separate tabs according to paragraph 1.07B.3a, above. That is, submittal data in individual tabs of a common submittal package shall be numbered sequentially, according to the applicable specification Section number.
   4. Replace rejected items and resubmit with acceptable items in accordance with the requirements of Division 01for Submittals, and with the Uniform General Conditions.
C. Within the specified time window after award of contract, submit list of equipment and materials to be furnished.
   1. Itemize equipment and material by specification section number; include manufacturer and identifying model or catalog numbers.
   2. Replace rejected items with an acceptable item within 2 weeks after notification of rejection.
   3. If a satisfactory replacement is not submitted within a two-week period, Owner will notify contractor as to equipment manufacturer or type and make or material to be furnished. Provide designated items at no additional cost to Owner.

D. Equipment Layout Drawing: 1/8-inch scale minimum drawings indicating electrical equipment locations. Dimensions for housekeeping pads shall be indicated on these drawings. Indicate routing of conduit 2 inches and over on these drawings.

E. Coordination Drawings: The Contractor shall prepare one complete set of composite drawings. The shop drawings for sheet metal ductwork shall be used as the basis for this coordination. When the sheet metal drawings have been prepared, the raceway, luminaires, mechanical piping, plumbing piping, and fire protection piping shall be overlaid and drafted onto the composite drawing. The intent of this process is to define areas of potential conflict and resolve those conflicts prior to fabrication or installation of work. In areas of congestion (where simply overlaying and drafting will create an unreadable product), the plan view scale shall be increased and multiple layered views shall be developed. Elevations of the individual elements shall be established, and elevations shall be drawn to illustrate that the ductwork, piping, raceway, and other systems and components will co-exist within the available space, and that the proper access to equipment, luminaires, valves, filters, etc. has been established for operation, service, removal and replacement. In addition to the above, the Contractor shall also submit the following for review:
   1. Electrical and Telecommunications Rooms. Submit 1/4-inch scale coordination drawings of electrical and telecommunications rooms indicating location of equipment. Indicate the exact location of each component in relation to other mechanical, electrical, and plumbing (MEP) components within each room. Include location(s) and quantity of raceway(s) and sleeve(s) stubbed up through floor slab for power, lighting, control, grounding, communications, and low-voltage system(s). These coordination drawings shall take into account the configuration of the mechanical, electrical, and telecommunications equipment which has been proposed and approved for use in the project, particularly where it differs in configuration from the equipment shown on the Drawings.
   2. Mechanical and Pump Rooms. Submit 1/4-inch scale coordination drawings of mechanical and pump rooms indicating location of electrical equipment. Indicate the exact location of each component in relation to other MEP components within each mechanical and pump room. These coordination drawings shall take into account the configuration of the mechanical and electrical equipment which has been proposed and approved for use in the project, particularly where it differs in configuration from the equipment shown on the Drawings.
   3. Auditorium, Lecture, Conference and Audio-Visual (A/V) Rooms. Submit 1/8-inch scale coordination drawings showing receptacles, snap switches, occupancy sensors, lighting controls, dimmers, communication outlets, and Audio-Visual (AV) outlets and devices (including projector mounts). Indicate locations and mounting heights of outlets and devices. Electrical, communication and AV devices shown in proximity to each other shall be grouped.
   4. Corridors. Submit 1/4-inch scale coordination drawings, including sections, of corridors indicating equipment and material.
   5. Building Information Modeling (BIM). Where a BIM-model of the project has been developed by the Architect/Engineer or Contractor, the BIM model may be used to develop and produce the coordination drawings. The Contractor and the individual trades
shall confirm in writing that the BIM-model and related coordination drawings accurately match the components and systems to be fabricated and installed.

6. Review: The completed “Composite Drawings” shall be submitted to the Architect/Engineer for review prior to installation. Work that proceeds without appropriate coordination and review will be subject to removal and relocation at no additional cost to the Owner.

F. Installation: Where product data or shop drawings are required, do not install equipment or materials until submittals are accepted by the Architect/Engineer and by Owner’s Representative. Use only equipment and materials accepted by the Architect/Engineer and by Owner’s Representative. Equipment and materials installed prior to acceptance by the Owner/Engineer and Owner’s Representative shall be removed at no additional cost to Owner and replaced at the Contractor’s expense.

G. Startup and Test Procedures:
1. Furnish documentation from equipment manufacturer for the startup and field testing procedures for equipment installed as a part of this project.
2. Startup and testing procedures shall include prerequisite conditions, system and equipment alignments and lineups, sequential steps for execution of the test, shutdown procedures, and criteria for satisfactory test completion and test failure.
3. Startup and testing procedures shall address and demonstrate modes of system or equipment operation, including startup, manual, unattended/automatic, and shutdown procedures, as well as procedures for testing and demonstration of abnormal or emergency operating conditions.
4. Include forms and logs to be used during field testing. Forms and logs shall include the range of permissible values for monitored parameters, as applicable.

H. As-Built and Record Drawings:
1. Maintain a master set of as-built drawings that show changes and other deviations from the Drawings. The markups must be made as the changes are done.
2. At the conclusion of the project, these as-built drawings shall be transferred to AutoCAD electronic files, in a format acceptable to the Owner’s Representative, and shall be complete.
3. Prior to final acceptance, deliver to the Owner’s Representative the AutoCAD electronic files, the complete set of record drawings showing the as-built condition of the project, and the actual field set of as-built drawings. Also deliver one set of as-built drawings on CD-Rom or similar electronic media acceptable to the Owner. Drawing files shall be in AutoCAD (.dwg) and Adobe Acrobat (.pdf).
4. Quantity: In accordance with the requirements of Division 01 and the General Conditions. Where not specified elsewhere, provide 3 hard copies plus one reproducible set.

I. Operating and Maintenance Manuals: As specified in Part 3 of this Section and in Division 01, as applicable.

J. Overcurrent Protective Device Coordination Study: Provide preliminary and final study as specified in Section 26 0573. Make adjustments to materials and submittals under other Sections of Division 26 as required and as recommended by the Overcurrent Protective Device Coordination studies.

1.8 SUBSTITUTIONS

A. Refer to requirements of Division 01 for substitution of Material and Equipment.
B. Product manufacturers are listed to establish a level of quality for the products. Substitutions may be allowed if the product is equal to or better than what is listed in the design guidelines, as determined by the Architect/Engineer and owner’s Representative upon submittal of comparison products.

C. Samples: When requested by the Owner’s Representative or the Architect/Engineer, the Contractor shall provide a sample of the proposed substitute item. When requested, provide samples of both the specified item and the proposed item for comparison purposes.

D. Timeliness: The burden of timeliness in the complete cycle of submittal data, shop drawings, and sample processing is on the Contractor. Time periods for Architect/Engineer processing and review of submittal data, shop drawings, samples, studies, and reports shall be in accordance with the applicable submittal and substitution requirements of Division 01 and the General Conditions. The Contractor shall allow sufficient time for review of each submission by the office of the design discipline involved after receipt of such submissions by that design discipline. The Contractor is responsible for allowing sufficient time in the construction schedule to cover the aforementioned cycles for processing of submittal data and shop drawings, including time for resubmittal cycles on unacceptable and rejected materials, equipment, components, and systems covered by the data submitted. Construction delays and lack of timeliness in the above regard are the responsibility of the Contractor and will not be considered in requests for scheduled construction time extensions and additional costs to the Owner.

E. Acceptance: Acceptance of materials and equipment will be based on manufacturer’s published data and will be tentative subject to the submission of complete shop drawings indicating compliance with the Drawings, specifications, and other applicable Contract Documents, and that adequate and acceptable clearances will exist for entry, servicing, and maintenance. Acceptance of materials and equipment under this provision shall not be construed as authorizing deviations from the Specifications, unless the attention of the Owner’s Representative and the Architect/Engineer has been directed in writing to the specific deviations. Data submitted shall not contain unrelated information unless pertinent information is properly identified.

F. Replacement: Should a substitution be accepted, and should the substitute material prove defective, or otherwise unsatisfactory for the service intended within the guarantee period, this material or equipment shall be replaced with the material or equipment originally specified at no additional cost to the Owner.

1.9 CONTRACTOR QUALIFICATIONS

A. An acceptable Contractor for the work under this division must have personnel with experience, training and skill to provide a practical working system.

1. The Contractor may be required to furnish acceptable evidence of having installed not less than three systems of size and type comparable to this project. The systems must have served satisfactorily for not less than 3 years. The superintendent must have had experience in installing not less than three such systems.

2. The Contractor must have personnel with the proper licenses to perform electrical work under this Contract. In accordance with the Texas Electrical Safety and Licensing Act – Title 8, Occupation Code, Chapter 1305, Subchapter D, section 1305.151: “LICENSE REQUIRED. Except as provided by Section 1305.003, a person may not perform electrical work unless the person holds an appropriate license issued or recognized under this chapter.”

B. The Contractor shall follow the safety procedures in addition to, and in accordance with, the requirements of the Project Safety Manual (PSM).
1. The Contractor shall be responsible for training personnel under their employ in areas concerning safe work habits and construction safety. The Contractor shall continually inform personnel on hazards particular to this project and update the information as the project progresses.

2. The Contractor shall secure electrical rooms, to limit access, prior to energizing high voltage (1000V or higher) equipment, and shall control access during the project after energization. The Contractor shall post and maintain warning and caution signage in areas where work is ongoing near energized equipment. The Contractor shall cover energized live parts when work is not being done in the equipment. This includes lunch and breaks.

3. The Contractor shall strictly enforce OSHA lockout/tagout procedures. Initial infractions shall result in a warning. A second infraction shall result in the removal of the workman and his foreman from the site. Continued infractions shall result in removal of the Contractor from the site.

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS

A. Condition. Provide new products of manufacturers regularly engaged in production of such equipment. Provide the manufacturer's latest standard design for the type of product specified.

B. NEC and UL.
1. Products must conform to requirements of the National Electrical Code. Where Underwriters’ Laboratories have set standards, listed products and issued labels, products used must be listed and labeled by UL.
2. Materials and equipment shall be labeled and/or listed as acceptable to the authority having jurisdiction as suitable for the use intended. Where no specifications or specific model numbers are given, provide materials of a standard industrial quality.

C. Space Limitations: Equipment selected must conform to the building features and must be coordinated with them. Electrical installation shall comply with the requirements of Article 110.26 and Article 110.34 of the National Electric Code (NEC) for working space, access, and dedicated equipment space. Do not provide equipment that will not suit arrangement and space limitations. Scaled drawings (1/4” = 1'-0”) of electrical and telecommunication rooms shall be submitted for review by the Architect/Engineer and the Owner’s Representative prior to installing equipment. See paragraph 1.07E above.

D. Factory Finish. Equipment shall be delivered with a hard surface, factory-applied finish so that no additional field painting is required except for touch-up as required.

E. Physical Size of Equipment: Equipment of larger sizes than shown, even though of specified manufacturer, will not be acceptable unless the Contractor demonstrates by product data, shop drawings, and coordination drawings that ample space exists for proper installation, operation, and maintenance.

F. Enclosure: Provide NEMA 1 enclosure for indoor installation and NEMA 4X for outdoor enclosure, unless noted or specified otherwise. The enclosure shall be suitable for the environment per NEC, NEMA and ANSI standards.

G. Conductors in Conduit: Conductors shall be installed in conduit. Exceptions are listed in individual Sections of the Division 26 and Division 28 specifications.
2.2 MANUFACTURER

A. Where two or more units of the same class of material are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer, except as specifically noted in individual Sections of the specifications.

2.3 SUBSTITUTIONS

A. Refer to Division 01 section on Material and Equipment, and to paragraph 1.08 of this Section.

2.4 NAMEPLATES AND DEVICE MARKING

A. Refer to Section 26 0553, Identification for Electrical Systems.

2.5 AUTOMATED EQUIPMENT AND CONTROLS

A. Equipment and control systems where applicable, shall match, integrate, communicate and cooperate with new and existing systems, such as building automation, energy management, direct digital controls (DDC), fire detection and alarm, circuit breakers, transformers, etc.

PART 3 - EXECUTION

3.1 GENERAL

A. Manufacturer’s Recommendations: The manufacturer’s published directions shall be followed in the delivery, storage, protection, installation, wiring, and connection of equipment and material. Promptly notify the Architect/Engineer and the Owner’s Representative in writing of conflicts between the requirements of the Drawings and specifications and the manufacturer’s directions, in accordance with paragraphs 1.05B and 1.06C of this Section. Obtain instructions from the Owner’s Representative before proceeding with the work. Should the Contractor perform work that does not comply with the manufacturer’s directions or such instructions from the Owner’s Representative, he shall bear costs arising in connection with the deficiencies.

B. Site Observation: Site observation by the Architect/Engineer is for the express purpose of verifying compliance by the Contractor with the Drawings, specifications, and other applicable Contract Documents. Site observation by the Architect/Engineer shall not be construed as construction supervision, or indication of approval of the manner or location in which the work is being performed, or as being a safe practice or place. Site observation by the Architect/Engineer shall not be construed as inspection by the Authority Having Jurisdiction (AHJ) or other applicable code enforcement authority.

C. Installation:
   1. The Contractor must have personnel with the proper licenses to perform electrical work under this Contract. In accordance with the Texas Electrical Safety and Licensing Act – Title 8, Occupation Code, Chapter 1305, Subchapter D, section 1305.151: “LICENSE REQUIRED. Except as provided by Section 1305.003, a person may not perform electrical work unless the person holds an appropriate license issued or recognized under this chapter.”
2. Where product data or shop drawings are required, do not install equipment or materials until submittals are accepted by the Architect/Engineer and by the Owner’s Representative. Use only equipment and materials accepted by the Architect/Engineer and the Owner’s Representative. Equipment and materials installed prior to acceptance by the Architect/Engineer and Owner’s Representative shall be removed at no additional cost to Owner and replaced at the Contractor’s expense.

D. Supervision:
1. The Contractor of the work under this Division shall keep a competent superintendent or foreman on the job throughout the period of construction. Refer to Division 01 requirements and the Uniform General Conditions for additional information concerning supervision.
2. It shall be the responsibility of such superintendent to study the Drawings, specifications, and other applicable Contract Documents, and familiarize himself with the work. He shall coordinate his work with other trades before material is fabricated or installed, and ensure that his work will not cause interference with another trade. Where interferences are encountered, they shall be resolved at the job site by the Contractor. Where interferences cannot be resolved without major changes to the Drawings, the matter shall be referred to the Architect/Engineer and the Owner’s Representative for resolution in accordance with paragraphs 1.05B and 1.06C of this Section.

3.2 PROTECTION OF EQUIPMENT AND MATERIALS

A. General:
1. The Contractor shall follow the manufacturer’s directions completely in the delivery, storage and handling of equipment and materials.
2. Equipment and materials shall be tightly covered and protected against dirt, water, chemical, physical or weather damage and theft. At the completion of the work, fixtures, equipment and materials shall be cleaned and polished thoroughly and shall be returned to “as new” condition.
3. Electrical cable, conductors and equipment shall be stored to prevent moisture and mechanical damage in an area that is protected from wind, rain or other exterior elements. Prior to installation, the building must be “dried-in” to prevent damage as stated above.

B. Moisture. During construction, protect switchboard, transformers, motors, control equipment, and other items from insulation moisture absorption and metallic component corrosion by appropriate use of strip heaters, lamps or other suitable means. Apply protection immediately on receiving the products and maintain continually. Equipment shall be protected against wind, rain or other exterior elements.

C. Clean. Keep products clean by elevating above ground or floor and by using suitable coverings.

D. Damage. Take such precautions as are necessary to protect apparatus and materials from damage. Failure to protect materials is sufficient cause for rejection of the apparatus or material in question.

E. Finish. Protect factory finish from damage during construction operations and until acceptance of the project. Satisfactorily restore finishes that become stained or damaged.

F. Weather. Protect equipment and materials from weather and sunlight by use of suitable coverings and storage indoors, or in suitable weather-protected containers. Materials and equipment marked by their manufacturer as suitable for storage outdoors may be stored...
according to manufacturer’s markings. Maintain factory-installed coverings and wrappings until material is to be installed.

3.3 PREPARATION

A. Coordination Drawings: The Contractor shall prepare one complete set of composite drawings. The shop drawings for sheet metal ductwork shall be used as the basis for this coordination. When the sheet metal drawings have been prepared, the raceway, luminaires, mechanical piping, plumbing piping, and fire protection piping shall be overlaid and drafted onto the composite drawing. The intent of this process is to define areas of potential conflict and resolve those conflicts prior to fabrication or installation of work. In areas of congestion (where simply overlaying and drafting will create an unreadable product), the plan view scale shall be increased and multiple layered views shall be developed. Elevations of the individual elements shall be established, and elevations shall be drawn to illustrate that the ductwork, piping, raceway, and other systems and components will co-exist within the available space, and that the proper access to equipment, luminaires, valves, filters, etc. has been established for operation, service, removal and replacement. In addition to the above, the Contractor shall also prepare the following:

1. Electrical and Telecommunications Rooms. Prepare 1/4-inch scale coordination drawings of electrical and telecommunications rooms indicating location of equipment. Indicate the exact location of each component in relation to other mechanical, electrical, and plumbing (MEP) components within each room. Include location(s) and quantity of raceway(s) and sleeve(s) stubbed up through floor slab for power, lighting, control, grounding, communications, and low-voltage system(s). These coordination drawings shall take into account the configuration of the mechanical, electrical, and telecommunications equipment which has been proposed for use in the project, particularly where it differs in configuration from the equipment shown on the Drawings.

2. Mechanical and Pump Rooms. Prepare 1/4-inch scale coordination drawings of mechanical and pump rooms indicating location of electrical equipment. Indicate the exact location of each component in relation to other MEP components within each mechanical and pump room. These coordination drawings shall take into account the configuration of the mechanical and electrical equipment which has been proposed for use in the project, particularly where it differs in configuration from the equipment shown on the Drawings.

3. Auditorium, Lecture, Conference and Audio-Visual (A/V) Rooms. Prepare 1/8-inch scale coordination drawings showing receptacles, snap switches, occupancy sensors, lighting controls, dimmers, communication outlets, and Audio-Visual (AV) outlets and devices (including projector mounts). Indicate locations and mounting heights of outlets and devices. Electrical, communication and AV devices shown in proximity to each other shall be grouped.

4. Corridors. Prepare 1/4-inch scale coordination drawings, including sections, of corridors indicating equipment and material.

5. Building Information Modeling (BIM). Where a BIM-model of the project has been developed by the Architect/Engineer or Contractor, the BIM model may be used to develop and produce the coordination drawings. The Contractor and the individual trades shall confirm in writing that the BIM-model and related coordination drawings accurately match the components and systems to be fabricated and installed.

6. Review: The completed “Composite Drawings” shall be prepared prior to installation. Work that proceeds without appropriate coordination will be subject to removal and relocation at no additional cost to the Owner.

B. Test Procedures:

1. Furnish documentation from equipment manufacturer for the startup and field testing procedures for equipment installed as a part of this project.
2. Startup and testing procedures shall include prerequisite conditions, system and equipment alignments and lineups, sequential steps for execution of the test, shutdown procedures, and criteria for satisfactory test completion and test failure.

3. Startup and testing procedures shall address and demonstrate modes of system or equipment operation, including startup, manual, unattended/automatic, and shutdown procedures, as well as procedures for testing and demonstration of abnormal or emergency operating conditions.

4. Include forms and logs to be used during field testing. Forms and logs shall include the range of permissible values for monitored parameters, as applicable.

3.4 SAFETY

A. Implement the following safety procedures in addition to, and in accordance with, the requirements of Division 01 and the Uniform General Conditions:

1. The Contractor shall be responsible for training personnel under their employ in areas concerning safe work habits and construction safety. The Contractor shall continually inform personnel of hazards particular to this project and update the information as the project progresses.

2. Prior to energizing panelboards within the scope of work, secure affected electrical rooms to limit access to line voltage. Line voltage shall be defined as above 50 volts, for the purpose of controlling access. During and after energization of panelboards, control access to electrical rooms for the duration of the project. Post and maintain warning and caution signage in areas where work is on-going near energized equipment. Cover energized live parts when work is not being done in the equipment. This includes lunch and breaks.

3. Strictly enforce OSHA lockout/tagout procedures. Initial infractions shall result in a warning. A second infraction shall result in the removal of the workman and his foreman from the site. Continued infractions shall result in removal of the Contractor from the site.

3.5 INSPECTION

A. Examination. Examine the areas and conditions under which equipment and systems are to be installed, and notify the Owner’s Representative in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

B. Coordination. Carefully investigate structural and finish conditions and coordinate the work in order to avoid interference between the various phases of work. Work shall be organized and laid out so that it will be concealed in furred chases, suspended ceilings, and similar elements in finished portions of the building, unless specifically noted to be exposed. Work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.

C. Inspections must be called before closing-in any wall for approval of Electrical.

3.6 INSTALLATION

A. Cooperation with Other Trades. Cooperation with trades of adjacent, related or affected materials or operations, and of trades performing continuations of this work under subsequent contracts, is considered a part of this work in order to effect timely and accurate placing of work and to bring together, in proper and correct sequence, the work of such trades. Provide other trades, as required, templates, patterns, setting plans and shop details for the proper installation of the work and for purposes of coordinating adjacent work. Electrical power connections for
B. Workmanship. Work shall be performed by workmen skilled in their trade. The installation shall be complete and installed in a neat and workmanlike manner in accordance with NEC 110.12 and FPM accompanying, and as described in ANSI/NECA 1-2000 “Standard Practices for Good Workmanship in Electrical Contracting” and other ANSI approved installation standards.

C. Concrete Equipment Pads.
1. Refer to structural Drawings and specifications for design criteria.
2. Where not otherwise indicated, install 4 inch thick reinforced concrete foundation pads for indoor floor-mounted equipment, except where direct floor mounting is required. For equipment mounted outdoors, provide concrete foundations a minimum of 6 inches above grade. Provide reinforcing steel as recommended by the structural engineer and as detailed on the Drawings. Pour pads on roughened floor slabs, sized so that outer edges extend a minimum of 4 inches beyond equipment. Trowel pads smooth with a slope per manufacturer’s recommendations and chamfer edges to a 1-inch bevel. Secure equipment to pads as recommended by the manufacturer.
3. Anchor Bolts. Furnish and install galvanized anchor bolts for equipment embedded within the concrete equipment pads or on concrete slabs. Bolts shall be of the size and number recommended by the manufacturer of the equipment and shall be located by means of suitable templates. When equipment is placed on vibration isolators, the equipment shall be secured to the isolator and the isolator secured to the floor, pad, or support as recommended by the vibration isolation manufacturer.

D. Setting of Equipment. Provide permanent and temporary shoring, anchoring, and bracing required to make parts stable and rigid; even when such shoring, anchoring, and bracing are not explicitly called for.
1. Equipment must be leveled and set plumb.
2. Sheet metal enclosures mounted against a wall shall be separated from the wall not less than 1/4 inch by means of corrosion-resistant spacers, or by 3 inches of air for freestanding units. Use corrosion-resistant bolts, nuts and washers to anchor equipment.
3. In sufficient time to be coordinated with work under other divisions, provide shop drawings and layout work showing exact size and location of sleeves, openings or inserts for electrical equipment in slabs, walls, partitions and chases.
4. Provide adequate support for freestanding panels, switchboards, enclosures, and other equipment. This shall include bolting to the floor, concrete equipment pad, or solid structural steel to prevent tipping. Install free-standing electrical equipment on concrete equipment pads in accordance with paragraph 3.05C, this Section, except where equipment is noted and designed for mounting directly on the concrete floor slab. Under no condition shall equipment be fastened to non-rigid building steel such as removable platform steel gratings, handrails, etc.
5. Provide racks and supports, independently mounted at structure, to support electrical equipment and systems supplied and installed under this contract. Do not mount or suspend equipment from supports provided for equipment and systems by other Divisions, except where specifically noted or indicated on Drawings.
6. Refer to Section 26 0529, Metal Framing and supports, for additional requirements.
7. Provide permanently marked NEC required clear space in front of and behind electrical equipment. Install markings on the floor using the color scheme conforming to ANSI Z535.1 for black and white striped border. Omit where installed in carpeted areas. Install space clearance labels were floor markings are not practical.

E. Sealing of Equipment. Seal openings into equipment to prevent entrance of animals, birds and insects, as well as to prevent ingress of moisture, dust, dirt, and similar contaminants.
F. Motors.
   1. Motors are specified in Divisions 21, 22 and 23.
   2. Electrical work includes the electrical connection of motors, except those which are wired as a part of equipment.
   3. Refer to Division 23 and other applicable Divisions for wiring and connection of motors and equipment furnished by those Divisions.
   4. The Contractor shall note that the electrical Drawings are based on the equipment scheduled and indicated on the Drawings. Should mechanical equipment be provided requiring changes to the electrical design, the required electrical changes shall be made at no cost to the Owner.
   5. Provide interconnecting wiring for the installation of the power required. Provide disconnect switches as required for proper operation, as indicated on the Drawings or required by applicable code. Combination starters, individual starters, and other motor starting apparatus, not specifically scheduled or specified as provided by the equipment manufacturer under the scope of other Divisions shall be provided under the scope of Division 26.
   6. Other Divisions will provide complete wiring diagrams indicating power wiring and interlock wiring. Diagrams shall be submitted to the Architect/Engineer for review.

G. Concealed Work. Conceal electrical work in walls, floors, chases, under floors, underground and above ceilings except:
   1. Where shown or specified to be exposed. Exposed is understood to mean open to view.
   2. Where exposure is necessary to the proper function.
   3. Where size of materials and equipment preclude concealment. Obtain the written consent of the Owner’s Representative and the Architect/Engineer to leave materials exposed in finished spaces of the building.

H. Application. Unless otherwise indicated, power will be utilized as follows:
   1. 208 volts, three phase: motors 1 horsepower and larger.
   2. 120 volts, single phase: motors 3/4 horsepower and smaller.
   3. 120 volts, single phase: fan powered boxes.
   4. 120 volts, single phase: decorative lighting.
   5. 120 volts, single phase: fluorescent and high-intensity-discharge lighting.
   6. 120 volts, single phase: convenience outlets, dedicated equipment, lab-track terminal boxes without fans.
   7. 208 volts, single and three phase: specialty outlets.
   8. 208 volts, three phase: special power and equipment; verify for each unit of equipment.

I. Connections to Equipment - Other than Division 26. For equipment furnished under other Divisions, and for equipment furnished by the Owner, provide final electrical connections to such items of equipment. Obtain detailed shop drawings of equipment from the applicable Division or supplier indicating the exact number and location of rough-in points. Such final shop drawings may indicate adjustments in total number and exact location of rough-in points, and in equipment dimensions. Making adjustments to field conditions is considered a part of the work required.
   1. Roughing-in: When roughing-in, provide electrical branch circuits to various items of equipment. Terminate at proper points as indicated on detailed equipment shop drawings, or as directed. Use Drawings accompanying these specifications only for general routing of circuiting. Do not use Drawings accompanying these specifications for rough-in locations.
   2. Final Connections: Millwork, casework, and similar equipment will include service fittings such as switches, duplex receptacles, data/communications outlets, and luminaires on
the casework or equipment. Provide branch circuit connection to match electrical connection requirements of service fittings.

J. Accessories. Offsets, fittings, expansion joints, anchors and accessories that are required for a complete system shall be provided, even if not specifically indicated on the Drawings or mentioned in the specifications. Offsets, transitions and changes in direction of conduit, cable trays, and raceways shall be made to maintain proper headroom. Provide pullboxes, fittings, etc., required as a result of these transitions and changes in direction.

K. Observation prior to cover-up or seal-in of walls and ceilings. Perform the following in accordance with the applicable requirements of Division 01 and the General Conditions:
1. Prior to the installation of ceiling material, gypsum, plaster, or acoustical board, the Contractor shall notify the Owner’s Representative so that arrangement can be made for observation or inspection of the above-ceiling area about to be “sealed” off. The Contractor shall provide advance notice in accordance with the applicable requirements of Division 01 and the General Conditions. Where not specified, required, or directed elsewhere, provide not less than 10 working days’ advance notice.
2. Above-ceiling areas will be subject to a formal inspection before ceiling panels are installed, or installation is otherwise concealed from view. Electrical work at and above the ceiling, including items supported by the ceiling grid, shall be complete and installed in accordance with contract requirements, including power to luminaires, fans, and other powered items. The purpose of this inspection is to verify the completeness and quality of the installation of the electrical systems and other above ceiling special systems such as cable tray systems. The ceiling supports shall be in place so that access panel and luminaire locations are identifiable, and so that clearances and access provisions may be evaluated.
3. No ceiling materials may be installed until the resulting deficiency list from this inspection is completed and approved by the Owner’s Representative.

L. Finish. Coordinate with Division 09 to paint exposed conduit to match adjacent walls, unless otherwise directed.

3.7 EXISTING FACILITIES

A. Responsibility. The Contractor shall be responsible for loss or damage to the existing facilities caused by him and his workmen, and shall be responsible for repairing or replacing such loss or damage. The Contractor shall send proper notices, make necessary arrangements, and perform other services required for the care, protection and maintenance of electrical services for new and existing facilities. The Contractor shall erect temporary barricades, with necessary safety devices, as required to protect personnel from injury, removing such temporary protection upon completion of the work.

B. Services. The Contractor shall provide temporary or new services to existing facilities or equipment as required to maintain their proper operation when normal services are disrupted as a result of the work being accomplished under this project.

C. Access. Where existing construction is removed to provide working and extension access to existing utilities, Contractor shall remove doors, piping, conduit, outlet boxes, wiring, luminaries, air conditioning ductwork and equipment, etc., to provide this access, and shall reinstall same upon completion of work in the areas affected.

D. Existing Devices. Where partitions, walls, floors, or ceilings of existing construction are indicated to be removed, remove and reinstall in locations approved by the Architect/Engineer devices required for the operation of the various systems installed in the existing construction.
This is to include, but is not limited to, temperature controls, system devices, electrical switches, relays, luminaires, fixtures, piping, conduit, etc.

E. Outages. Outages of services as required by the new installation will be permitted, but only at a time approved by the Owner. The Contractor shall coordinate with the Owner’s Representative to arrange for service outages. The Contractor shall allow the Owner sufficient time to schedule for required outages, in accordance with the applicable requirements of Division 01 and the General Conditions. Where not specified, required or directed elsewhere, allow a minimum of 21 working days for the Owner to schedule for required outages. The time allowed for outages will not be during normal working hours or during hours of research and instruction, unless otherwise approved by the Owner’s Representative. Costs of outages, including overtime charges, shall be included in the contract amount.

F. Adjacent Facilities. Coordinate work among the various trades to minimize disruption to existing processes, procedures, and equipment in spaces adjacent to areas of demolition and renovation work. Coordinate with Owner’s Representative to schedule work producing noise or structure-borne vibrations, including but not limited to cutting, drilling, coring, and use of impact tools.

3.8 EQUIPMENT AND DEVICE MARKING

A. Designations. Identify equipment, devices, feeders, branch circuits and similar items with the same designations as indicated on the Drawings.

B. Nameplates. Externally mark electrical equipment with nameplates identifying each and the equipment served. Supply blank nameplates for spare units and spaces.

C. Refer to Section 26 0553 for additional requirements.

3.9 SLEEVES, PENETRATION, CUTTING AND PATCHING

A. General. Cut and patch walls, floors, etc., resulting from work in existing construction. Provide for the timely placing of sleeves for raceway and exposed cabling passing through walls, partitions, beams, floors and roof while same are under construction. If openings, sleeves, and recesses are not properly installed and cutting and patching become necessary, it shall be done at no expense to the Owner. Secure permission from the Owner’s Representative before cutting or patching a constructed or existing wall. Where roofs or walls are fire rated, penetrations shall be completely sealed using UL-listed materials and procedures sufficient to preserve the fire rating. Comply with special requirements of local authorities.

B. Structure. Do not cut or core through structural beams, joists, load-bearing walls, grade beams, or similar load-bearing structure. Where limited space is available above the ceilings below concrete beams or other deep projections, notify the Owner’s Representative in writing, including a proposed solution, and request a resolution. Approval shall be obtained from the Owner’s Representative and the Architect/Engineer for each penetration.

C. Penetrations.
1. This contract requires core drilling of floor or wall penetrations as indicated on Drawings. Core drilling shall be in accordance with structural specifications. Floor penetrations shall include a sleeve that extends above the floor 2 inches, except where plugs and caps are specified or indicated flush with floor or foundation pad. Electrical penetrations shall be coordinated with structure during design, and shall be made in compliance with structural requirements specified in the structural Drawings and specifications. Field modifications are required to be reviewed and approved by structural engineer prior to installation.
2. Penetrations shall be sealed in accordance with the requirements of Division 07, Firestopping. Coordinate with Division 07 to provide firestopping systems and materials that are compatible with the penetrations for systems and equipment furnished and installed under Division 26.

3. Provide sleeves for conduit penetrations of smoke, fire, and sound rated partitions. Install sleeve with a minimum of 1 inch diameter where penetrating the exterior drywall.

4. Provide proper sizing of sleeves or core-drilled holes to accommodate their through-penetrating items. In general, provide conduit sleeves two standard sizes larger than their through-penetrating items. Provide larger sleeves as required to allow passage of couplings for through-penetrating items.

5. X-Ray the slab prior to core drilling to verify the location of rebar or other structural items in the slab.

D. Sealing and Firestopping.
1. Voids between sleeves or core-drilled holes and pipe passing through fire-rated assemblies shall be firestopped to meet the requirements of ASTM E814 or UL 1479, in accordance with Division 07 requirements for Firestopping.

2. Where the routing of cable tray passes through fire-rated walls, floors or other fire-rated boundaries, coordinate with Division 07 to provide removable firestopping system.

3. Furnish and install UL Systems Classified, intumescent material capable of expanding up to 8 to 10 times when exposed to temperatures beginning at 250° F, for the sealing of holes or voids created to extend electrical systems through fire rated floors and walls, in order to prevent the spread of smoke, fire, toxic gas or water.

4. Fire barrier products shall be used to create through-penetration firestop systems as required. Firestop systems shall be listed in the Underwriter’s Laboratories Building Materials Discovery, Through Penetration Firestop Systems (XHEZ).

5. Install firestop materials and systems according to their UL Systems Classifications, manufacturer instructions, manufacturer recommendations, and the requirements of applicable Division 7 specifications.

E. Conduit Sleeves. Conduit sleeve shall be two standard sizes larger than the size of conduit it serves, except where “Link Seal” casing seals are used in sleeves through walls below grade. Sleeves in floor shall extend a minimum of two inches above the finished floor. Conduit passing through concrete masonry walls above grade shall have 18-gauge galvanized steel sleeves. Sleeves set in concrete floor construction shall be at least 16-gauge galvanized steel except at conduit supports. Sleeves set in concrete floor construction supporting conduit risers shall be standard weight galvanized steel. Sleeves supporting conduit risers 3 inches and larger shall have three 6 inch long reinforcing rods welded at 120 degree spacing to the sleeve, and shall be installed embedded in the concrete or grouted to existing concrete. Where the conduit passes through a sleeve, no point of the conduit shall touch the sleeve. Seal around penetrations through sleeving as indicated under firestopping as specified herein, and in compliance with the requirements of Division 07 specifications.

F. Penetrations Below Grade. Sleeves penetrating walls below grade shall be standard weight black steel pipe with 1/4-inch thick steel plate secured to the pipe with continuous fillet weld. The plate shall be located in the middle of the wall and shall be two inches wider in radius than the sleeve it encircles. The entire assembly shall be hot-dipped galvanized after fabrication. Seal off annular opening between conduit and sleeve with “Link Seal” casing seal as manufactured by Thunderline Corporation of Wayne, Michigan. Size conduit sleeve to accommodate the casing seal. Use Series 300 casing seals for pipe 3/4-inch through 4-inch and Series 400 casing seals for pipe sized 5-inch and larger.

G. Methods of Cutting: Openings cut through concrete and masonry shall be made with masonry saws and core drills, and at such locations acceptable to the Owner’s Representative. Impact type equipment shall not be used except where specifically accepted by the Owner's
Representative. Openings in precast concrete slabs for conduits, outlet boxes, etc., shall be core drilled to exact size.

H. Restoration. Restore openings to “as new” condition under the appropriate specification Section for the materials involved, and match remaining surrounding materials and/or finishes.

I. Masonry. Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry. Provide adequate supports during the cutting operation to prevent damage to the masonry caused by the cutting operation. Structural members, supports, etc., shall be of the proper size and shape, and shall be installed in a manner acceptable to the Owner’s Representative.

J. Structure. No cutting, boring, or excavating which will weaken the structure shall be undertaken. Coordinate with structure for placement of conduit, sleeves, and the like through beams, joists, slabs, mats, and other structural components and systems prior to forming of those structural components and systems.

K. Watertight. Where sleeves pass through roof or floors requiring waterproof membrane, lead flashing with a density of at least three pounds per square foot shall be built into the membrane a minimum of six inches to provide a watertight installation. Provide other watertight installation materials as detailed on the Drawings and as specified under Division 07 – Roofing.

L. Escutcheons. Provide heavy chrome-plated or nickel-plated plates on conduit passing through walls and ceilings in finished areas. Escutcheons shall be B&C No. 10, or accepted substitution, chrome-plated steel plates with concealed hinges.

M. Roof Penetrations and Flashings. Furnish and install pipe, conduit and duct sleeves, and flashing compatible with the roofing installation for roof penetrations. Coordinate with Division 07.

3.10 CLEANING, ADJUSTING AND START-UP

A. Cleaning. Clean electrical equipment, components, and devices prior to installation of final finish or covers, prior to startup and testing, prior to final observation by Architect/Engineer and Owner’s Representative, and as required under individual Sections of the Division 26 specifications.

B. Adjusting. Adjust equipment, devices, and systems as specified under individual Sections of these Specifications and in accordance with manufacturer’s instructions for proper functioning during modes of operation, including emergency and shutdown conditions.

C. Factory Authorized Representative. Where specified for an individual item of electrical equipment, provide a factory authorized representative for adjustment, start-up, and testing of equipment, and instruction of Owner’s operating personnel. Certify that these services have been performed by including a properly executed invoice for these services or a letter from the manufacturer.

3.11 TESTING

A. Test Conditions. Use field startup and testing procedures submitted in accordance with paragraph 1.07H of this Section and accepted by the Owner’s Representative and the Architect/Engineer. Place circuits and equipment into service under normal conditions,
collectively and separately, as necessary to determine satisfactory operation. Perform specified
tests in the presence of the Owner's Representative. Furnish instruments, wiring, equipment
and personnel required for conducting tests. Demonstrate that the equipment operates in
accordance with requirements of the Drawings and specifications. Special tests on certain items,
when required, are specified in the individual specification Sections. Where testing is specified
or otherwise required to be performed by an independent testing company, use an Owner-
approved NETA-certified testing company.

B. Test Conditions. Use field startup and testing procedures prepared in accordance with
paragraph 3.03B of this Section. Place circuits and equipment into service under normal
conditions, collectively and separately, as necessary to determine satisfactory operation.
Perform specified tests in the presence of the Owner's Representative. Furnish instruments,
wire, equipment and personnel required for conducting tests. Demonstrate that the equipment
operates in accordance with requirements of the Drawings and specifications. Special tests on
certain items, when required, are specified in the individual specification Sections. Where
testing is specified or otherwise required to be performed by an independent testing company,
use an Owner-approved NETA-certified testing company.

C. Test Dates. Schedule final acceptance tests sufficiently in advance of the contract completion
date to permit adjustment and alterations within the number of days allotted for completion of the
contract. Inform the Owner’s Representative in advance of test dates in accordance with the
applicable requirements of Division 01 and the General Conditions. Where not specified,
required, or directed otherwise, allow a minimum of at least 10 working days advance notice.

D. Retests. Conduct retests as directed by the Owner’s Representative of such time duration as
may be necessary to assure proper functioning of adjusted or altered parts or items of
equipment. Delays resulting from retests do not relieve the Contractor of his responsibility under
this contract.

E. Commissioning. Coordinate with commissioning agent, as applicable, for field testing and
commissioning of electrical components and systems.

F. Test Reports. Submit copies of test reports to the Architect/Engineer in accordance with
Division 01 requirements.

3.12 OPERATING AND MAINTENANCE MANUALS

A. General. The Contractor shall provide, in loose-leaf binders, complete operating and
maintenance data of each manufactured item of equipment used in the electrical work at least
four weeks before Architect/Engineer’s final review and observation of the project. Descriptive
data and printed installation, operating and maintenance instructions for each item of equipment
will be included. A complete double index will be provided as follows.

B. Format and content. The Operating and Maintenance Manual will be submitted in quantities and
format as specified under Division 01 for Submittals. Provide quadruplicate where quantity is
not specified. Operating and Maintenance Manual shall include:

1. Descriptive data of each system and piece of equipment, including ratings, capacity,
   performance data, operating curves and characteristics, and wiring diagrams.
2. Full detailed spare parts list, including source of supply for each piece of equipment.
   Where spare parts are not recommended by the manufacturer, indicate as such in the
   appropriate section.
3. Printed instructions describing installation, operation, service, maintenance, and repair of
each piece of equipment.
4. Typewritten test and start-up reports of tests made of materials, equipment and systems under this Division. Test reports will include the dates of the tests, name of person conducting and witnessing the tests, and record of conditions relative to the tests.

5. Copies of “Reviewed” shop drawings and submittals.

6. Print copies of the record Drawings. Refer to paragraph 1.07I of this Section.

END OF SECTION
SECTION 26 0001

ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Electrical demolition.

1.2 RELATED WORK

A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total requirements for electrical demolition.
   1. Division 01.
   2. Division 21, Fire Suppression.
   3. Division 22, Plumbing.
   4. Division 23, Heating, Ventilating, and Air Conditioning.
   5. Section 26 0000, Electrical General Provisions.

B. In the event of conflict regarding minor electrical demolition requirements between this Section and other Sections, the provisions of this Section shall govern.

1.3 EXISTING FACILITIES

A. The Contractor shall be responsible for loss or damage to the existing facilities caused by him and his workmen, and shall be responsible for repairing or replacing such loss or damage. The Contractor shall send proper notices, make necessary arrangements, and perform other services required for the care, protection and in service maintenance of electrical services for the new and existing facilities. The Contractor shall erect temporary barricades, with necessary safety devices, as required to protect personnel from injury, removing temporary protection upon completion of the work.

B. Provide temporary or new services to existing facilities to maintain their proper operation when normal services are disrupted as a result of the work being accomplished under this project. See plans for complete requirements.

C. Where existing construction is removed to provide working and extension access to existing utilities, Contractor shall remove doors, piping, conduit, outlet boxes, wiring, luminaires, air conditioning ductwork and equipment, etc., to provide this access and shall reinstall same upon completion of work in the areas affected.

D. Where partitions, walls, floors, or ceilings of existing construction are indicated to be removed, remove and reinstall in locations approved by the Architect/Engineer the devices required for the operation of the various systems installed in the existing construction. This is to include but is not limited to temperature controls, system devices, electrical switches, relays, luminaires, fixtures, piping, conduit, raceway, etc.
E. Outages of services as required by the new installation will be permitted but only at a time approved by the Owner. The Contractor shall allow the Owner 21 working days in order to schedule required outages. The time allowed for outages will not be during normal working hours unless otherwise approved by the Owner. Costs of outages, including overtime charges, shall be included in the contract amount.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment for Patching and Extending Work: As specified in individual Sections.

B. Provide materials necessary for work.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Demolition and modifications to existing systems shall be coordinated through Owner’s Representative. Demolition drawings are based on casual field observation and existing record documentations. Therefore the accuracy or exactness of the drawings is not guaranteed. The Contractor shall verify that field measurements and circuiting arrangements are as shown on Drawings and abandoned wiring and equipment serve only abandoned facilities. The Contractor shall be responsible for reporting discrepancies to the Architect/Engineer and the Owner’s Representative before disturbing existing installation.

B. Beginning of demolition means Contractor accepts existing conditions.

3.2 PREPARATION

A. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal. Provide temporary wiring and connections to maintain remaining systems in service during demolition and/or modification as detailed on plans. Owner reserves the right up to 24 hours prior to scheduled event to delay or suspend shutdowns or outages to more convenient times at no additional cost.

B. Existing Electrical Service: Existing service shall be removed after temporary service is operational.

C. Existing Fire Alarm System: Maintain existing system in service in selected areas as detailed in plans. Disable system only to make switchovers and connections. Notify Owner at least 21 working days before partially or completely disabling system. Schedule work so as to minimize outage duration. Provisions for manual fire watch shall be provided in areas where services are interrupted. Areas to remain in operation are clearly noted on the plans. The contractor shall be responsible for relocating/adding any new power supplies, transponder panels etc. to keep the selected areas in operation. Any devices that are relocated or added shall be installed in locations unaffected by demolition. The fire alarm system shall continue to report its alarms via dialed to offsite monitoring. The contractor is responsible for any additional conduit and wiring required to keep the fire alarm system operational.
D. Existing Telephone and Voice/Data Communications System: See Telecom plans.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Remove, relocate, and extend existing installations to accommodate work as indicated on plan drawings. Unless otherwise noted, remove electrical materials and equipment from areas indicated for demolition. Removal of equipment shall not interfere with existing operations.

B. Remove all electrical devices, conduit and wire in the demolition areas. The exception to this is that conduit serving areas that will remain in operation shall be reused where possible for temporary power.

C. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.

D. Extend existing installations using materials and methods compatible with existing electrical installation, structure, and finishes, or as specified.

E. Where existing circuits serving areas to remain extend through areas indicated for demolition, maintain those existing circuits and devices in operating condition. Coordinate outages and interruptions of existing circuits with Owner to minimize interruption of ongoing operations and instruction. Provide raceway and supports to reconnect existing circuits to remain. Promptly reconnect and restore circuits following outages and interruptions.

3.4 CLEANING AND REPAIR

A. The Contractor shall follow the requirements of the General and Supplementary Conditions, Division 01, including Owner’s clean work policy, and shall include the removal of trash and demolished material from the building or work area at the end of each day and removal from the site once a week.

B. The Contractor shall be responsible for repairing adjacent construction and finishes damaged during demolition and/or modification. The Contractor shall be responsible for the removal of ceiling tiles required in the demolition work. The Contractor shall be responsible for the replacement of damaged tiles and reinstallation of the ceiling prior to final acceptance.

3.5 DISPOSITION OF MATERIAL AND EQUIPMENT

A. Review with Owner the materials that have been removed and are no longer required, to determine which materials the Owner may desire to keep. Deliver those materials that the Owner desires to the Owner’s specified location.

B. For those materials not required by the Owner, dispose of them in accordance with applicable regulations.
C. Materials and equipment to be removed, except items specifically listed to be relocated or delivered to the Owner, become the property of the Contractor and shall be immediately removed from the project site.

D. Dispose of lamps containing mercury and ballasts containing PCB’s per EPA regulations.

END OF SECTION
SECTION 26 0519
INSULATED CONDUCTORS

PART 1 - GENERAL

1.1 SUMMARY
A. This Section specifies the furnishing and installation of insulated conductors.

1.2 REFERENCE STANDARDS
B. ANSI/UL 83 - Thermoplastic-Insulated Wires and Cables.
C. ICEA S-61-402 (NEMA WC 5) - Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
D. ANSI/UL 2196 "Tests for Fire Resistive Cables"
E. CSA C22.2 #124
F. UL Fire Resistance Directory

1.3 SUBMITTALS
A. Provide product data on the following:
   1. 600-volt conductor, splicing and terminating materials.
   2. MI cable

PART 2 - PRODUCTS

2.1 IDENTIFICATION
A. Provide new insulated conductors marked according to NEC Article 310.

2.2 600-VOLT INSULATED CONDUCTORS
A. Size. As shown on the drawings.
B. Construction.
   1. Conductor. Soft-drawn, annealed copper. Solid for #12 and #10 and Stranded for all other sizes.
2. Insulation. Unless otherwise noted on the drawings, use THHN/THWN-2 for general wiring. Use XHHW-2 for conductors installed below grade and outdoors.

C. Use. For general wiring use No. 12 minimum. For field-installed control wiring use No. 14 or larger stranded conductors.

D. Listing. Single Conductor. UL 83.

2.3 TYPE MI – MINERAL INSULATED CABLE

A. Size as shown on drawings

B. Construction
   1. Conductor: Solid high conductivity copper
   2. Insulation: 600V, magnesium oxide
   3. Fire Rating: Complex cable system shall have a 2 hour fire rating as used and classified by Underwriters Laboratories, Inc.

C. Manufacturer: Pentair/Pyrotenax

PART 3 - EXECUTION

3.1 INSTALLATION

A. Protection. Unless otherwise indicated, mechanically protect conductors for systems by installing in raceways. Do not install the conductors until raceway system is complete and properly cleaned. Use Polywater J cable lubricant when pulling conductors. Do not bend any conductor either permanently or temporarily during installation to radii less than four times the outer diameter of 600-volt insulated conductors, or less than twelve times the outer diameter of the completed 15 kV cable. Do not exceed manufacturer's recommended values for maximum pulling tension.

B. Splices and Terminations. Use pressure-type lugs or connectors for terminations or splices of all stranded conductors. Current crimping tool certification is required for crimping tools. Use ring-tongue type terminators on all control wiring. Push-in style connectors are not approved for use.

C. Appearance. Neatly and securely bundle or cable all conductors in an enclosure using nylon straps with a locking hub or head on one end and a taper on the other.

3.2 600-VOLT INSULATED CONDUCTORS

A. Size. Install conductor sizes as indicated.

B. Home Runs. Provide branch circuit homeruns as indicated on plans. Homerun designations are indicated on Sheet E-001. Provide the number of homeruns as indicated on plans. A maximum of 6 phase conductors may be installed in one conduit. Include a separate neutral conductor with each phase conductor for all 120V circuits. Common neutrals are not permitted. For 277V lighting circuits one neutral conductor may be used for three phase conductors. Use home run circuit numbers as indicated for panelboard connections. For isolated ground circuits provide an
additional ground conductor as indicated on the panel schedules. Provide No. 10 AWG conductor for the entire circuit length for single-phase, 20 ampere circuits for which the distance from panelboard to the last outlet is more than 100 feet for 120 volt circuits and 200 feet for 277 volt circuits.

C. Color Code. Use factory-colored insulated conductors for No. 10 and smaller conductors and color code larger insulated conductors with an approved field-applied tape. Use different colors for control wiring. Follow the color scheme below.

<table>
<thead>
<tr>
<th>Line</th>
<th>208/120</th>
<th>480/277</th>
</tr>
</thead>
<tbody>
<tr>
<td>A or L1</td>
<td>Black</td>
<td>Brown</td>
</tr>
<tr>
<td>B or L2</td>
<td>Red</td>
<td>Purple</td>
</tr>
<tr>
<td>C or L3</td>
<td>Blue</td>
<td>Yellow</td>
</tr>
<tr>
<td>Neutral</td>
<td>White</td>
<td>Gray</td>
</tr>
<tr>
<td>Ground</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Switch Leg</td>
<td>Pink or Violet</td>
<td>Pink or Violet</td>
</tr>
</tbody>
</table>

Where more than one conductor of the same phase or more than one neutral conductor occurs at the same outlet or junction box, these conductors shall be identifiable from each other by use of stripes or distinguishing markings. All wiring associated with isolated ground receptacles (line, neutral, ground) shall have a yellow tracer on each conductor.

D. Field Testing. Insulation resistance of all conductors shall be tested. Each conductor shall have its insulation resistance tested after the installation is completed and all splices, taps and connections are made except connection to or into its source and point (or points) of termination. Insulation resistance of conductors which are to operate at 600 volts or less shall be tested by using a Biddle Megger of not less than 1000 volts d-c. Insulation resistance of conductors rated at 600 volts shall be free of shorts and grounds and have a minimum resistance phase-to-phase and phase-to-ground of at least 10 megohms. Conductors that do not exceed insulation resistance values listed above shall be removed at Contractor's expense and replaced and test repeated. The Contractor shall furnish all instruments and personnel required for tests, shall tabulate readings observed, and shall forward copies of the test readings to the Owner in accordance with Section 26 05 00. These test reports shall identify each conductor tested, date and time of test and weather conditions. Each test shall be signed by the party making the test.

3.3 TYPE MI – MINERAL INSULATED CABLE

A. Size – Install conductor sizes as indicated.

B. Home runs: Install cable per manufacturer’s instructions

C. Color Code/label: Label each individual cable every 5’ with the following: 600V 2HR fire rated cable.

END OF SECTION
PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section specifies the furnishing and installing of grounding and bonding equipment for electrical systems.

1.2 REFERENCE STANDARDS


C. ANSI/TIA/EIA 607 - Commercial Building Grounding and Bonding Requirements for Telecommunications.

D. ANSI/UL 467 - Grounding and Bonding Equipment.


G. NFPA 70 - National Electrical Code (NEC).

1.3 RELATED WORK

A. Division 27, Communications.

B. Division 28, Electronic Safety and Security.

1.4 SUBMITTALS

A. Product Data. Submit product data sheets, including complete descriptive information on materials and installation methods.

B. Shop Drawings.

1. Provide detailed plans prepared to 1/8-inch scale with 1/8-inch text which indicate the work to be performed. Details of component mounting and connections shall be included on separate detail drawings. Manufacturer's catalog numbers and generic identification shall be indicated for components shown on the Drawings.
2. Shop drawings shall include locations of conductors, roof penetrations, floor penetrations, etc., and their compatibility with provisions made during the construction. Once the contract has been established the Contractor shall make a review of provisions being made for the system installation and comment, in writing, with changes or compliance within two weeks of finalizing the contract. Contractor shall coordinate locations of conductors in walls and penetrations with the appropriate trades. Failure to coordinate these requirements shall not relieve this Contractor from properly completing this work. The Contractor shall employ the proper trades to provide the chases in walls and roof and floor penetrations required to install the conductors if not coordinated before the floors, walls and roof are installed.

C. Coordinated Submittal.
1. Coordinate submittal for grounding system with electrical service to building and with electrical service equipment.
2. Coordinate submittal for grounding system with telecommunications grounding system, as indicated on telecommunications Drawings. Refer to Division 27 telecommunications systems grounding system and grounding requirements.

D. Approvals: Secure formal approval of shop drawings and product data prior to ordering material. Secure approvals in sufficient time to allow installation of concealed system components without delaying the project.

E. Testing: Submit documentation for field testing of completed grounding system, as required under paragraph 3.5B of this Section.

F. As-Built Record Drawings. The Contractor shall maintain a master set of As Built record drawings that shows changes and deviations from the Drawings, in accordance with Division 01 requirements and Section 26 0000.

PART 2 - PRODUCTS

2.1 CONNECTIONS
A. Materials. Unless otherwise noted, provide exothermic welded type grounding connections for bonds and connections made below grade, embedded in structure, or otherwise concealed. For above grade connections not embedded in structure or otherwise concealed, provide mechanical bolted-type connections utilizing high-conductive copper alloy or bronze lugs or clamps. Where required, provide plated connectors which will not cause electrolytic action between the conductor and the connector.

B. Listing. UL 467.

2.2 CONDUCTORS
A. Materials. Provide grounding conductors fabricated from annealed copper with conductivity \( \geq 98 \) percent IACS conductivity.
1. Use solid conductor for No. 12 and No. 10 AWG.
2. Use stranded conductor for No. 8 AWG and larger.
3. Use stranded conductor for applications subject to continuous vibration, such as engine generators and terminations at motors.
4. Use stranded, tinned, annealed copper cable for #2 AWG or larger installed inside the building or structure.

B. Insulation. Where insulated grounding conductors are specified or required, provide green-colored 600-volt rated insulation, type XHHW, THWN, or RHW. Insulation type shall be compatible with associated power and lighting system conductors.

C. Location and Application.
1. Inside building or structure. Provide insulated copper grounding conductors, except where bare copper grounding conductors are indicated on Drawings or specified in this or other Sections.
2. Outside building or structure. Use bare copper grounding conductors, including below-grade building grounding ring (counterpoise).

D. Listing. UL 83.

2.3 GROUND BUS

A. Where a field-provided ground bus-bar is required or indicated, provide bus-bar drilled and tapped with double-lug terminations for the quantity of ground connections indicated on the Drawings plus 25% spare capacity, wall-mounted on insulated supports. Use round-edge copper bar with > 98 percent International Annealed Copper Standard (IACS) conductivity. Size the bus-bar for not less than 25 percent of the aggregated cross-sectional area of the related feeders. A minimum cross-sectional size of 1/4 inch by 2 inches is required; where ground bus-bar of larger dimensions is indicated on plans or specifications provide the bus-bar with the larger dimensions.

2.4 MANUFACTURER

A. Copperweld.
B. Cadweld.
C. Burndy.
D. Harger.

PART 3 - EXECUTION

3.1 GENERAL

A. Install grounding system in accordance with the requirements of the National Electrical Code (NEC), Article 250, and other applicable codes and standards. Coordinate installation of grounding system components with other work and placement of building structural mat.

B. Install grounding conductors continuous, without splice or connection, between equipment and grounding electrodes. Connection to ground busbars is permitted as an exception to the restriction against splices in grounding conductors. Grounding conductors shall be as short and straight as possible, and protected from mechanical damage.
C. Install fusion welded (exothermic) grounding connectors where they are concealed or inaccessible. Above grade at accessible locations, use copper or bronze lugs and clamps. Grounding system connections made in conjunction with placement of the building structural mat shall be exothermic ground connectors.

D. Strap grounding clamps shall not be used. Connections requiring bolting shall be made up with Monel metal bolts, washers and nuts. Connections shall be made only after surfaces have been cleaned, or ground to expose virgin metal.

E. Where grounding conductors are installed in raceway, provide Schedule 40 PVC conduit inside the footprint of the building, and Schedule 80 PVC conduit for exterior or other locations outside the footprint of the building. Where exposed inside the envelope of the building, install grounding conductors in metallic raceway unless specifically indicated on Drawings to omit raceway. Where grounding conductors are installed in metallic raceway, bond to each end of metallic raceway where grounding conductors enter or exit the metallic raceway system. Metallic raceway systems that would form electrically inductive chokes shall not be used.

F. Conductor connections shall be made by means of solderless connectors such as serrated bolted clamps or split bolt and nut type connectors.

3.2 SYSTEM DESCRIPTION

A. Provide ground bus-bar, wall-mounted on insulated supports at 8'-0" AFF in electrical rooms, and radially connected to a master ground bus-bar in the main electrical room. See paragraph 3.4A, this Section.

B. Separately Derived Systems: Ground the neutral of each separately derived system in accordance with NEC-250.30 and paragraph 3.3D, this Section.

C. Provide communications system-grounding conductor at point of service entrance and connect to separate grounding electrode. Bond together the communications system grounding electrode and the electrical service-grounding electrode. Separate grounding systems without interconnecting bonds or jumpers are prohibited.

D. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.

3.3 SYSTEM GROUND

A. System Neutral. Where a system neutral is used, ground the system neutral as required by NEC Article 250 and as indicated on Drawings. Ground the system neutral only at the point of service and isolate it from ground at all other points in the system.

B. Size. Size the system grounding electrode conductors as indicated on plans.

C. Install grounding electrodes around exterior perimeter of building, a minimum of 3 feet outside the foundation of the building or facility. Space grounding electrodes at a distance between electrodes of at least twice their driven depth. Bond together ground rods by building ground ring (counterpoise). Install grounding electrode conductor in undisturbed earth, a minimum of 2 feet below excavated depth of building structural mat, crawlspace, or sub-grade.
D. Separately Derived Systems. Ground neutrals of separately derived systems such as generators and transformers in accordance with NEC 250.30 and as indicated on Drawings.
   1. For each separately derived system, ground the neutral to system ground via the nearest ground busbar specifically provided for the purpose of grounding power distribution systems. Use unspliced grounding conductor from the neutral of the separately derived system to the ground busbar.
   2. Grounding conductors shall be as short and straight as possible, protected from mechanical damage, without splice or joint except as permitted by NEC 250.30.
   3. Transformers: Bond the center point (neutral or X0 terminal) of each wye-connected transformer to system ground at one point only. This point shall be ahead of the first overcurrent protective device (OCPD) connected to the secondary winding of the transformer. Refer to the applicable transformer specification for additional requirements.
   4. Panelboards: Provide bond between the neutral and ground bus bars.

3.4 EQUIPMENT GROUND

A. Provide a ground bus where indicated on Drawings.
   1. Mount busbar 4 feet above finished floor and a minimum of 1 inch from wall.
   2. Connect busbar by grounding conductor to the main ground busbar at the main electrical room. Size grounding conductor as shown on Drawings. Where size is not indicated, use grounding conductor with cross-sectional area equivalent to the ground busbar.
   3. Connect to the ground bus noncurrent-carrying metallic parts of electrical equipment and enclosures in the room.
   4. Bond grounding conductors to the bus as further indicated on Drawings.
   5. Make equipment grounding connection to copper loop by exothermic weld, where direct connection to ground bus-bar is not feasible.

B. Raceway Systems and Equipment Enclosures.
   1. Bond cabinets, cable trays, junction boxes, outlet boxes, motors, controllers, raceways, fittings, switchgear, switchboards, panelboards, transformer enclosures, other electrical equipment and metallic enclosures. Bond equipment and enclosures to the continuous-grounded, metallic raceway system in addition to other specific grounding shown. Ground each outlet by the use of an approved grounding clip attached to the outlet box in such a position to be readily inspected upon removal of the cover plate, or by the use of an approved grounding yoke type receptacle.
   2. Provide bonding jumpers and grounding conductors throughout the raceway system to ensure electrical continuity of the grounding system and the raceway.
   3. Provide grounding-type insulated bushings for metal conduits 1-1/2 inches and larger terminating in equipment enclosures containing a ground bus. Connect the bushing to the ground bus in the equipment enclosure.
   4. Provide a green insulated equipment grounding conductor for each feeder and branch circuit. Terminate each end of grounding conductor on a grounding lug, bus, or bushing.
   5. Provide internal grounding conductor on liquid tight flexible metal conduit (“sealtite”) with ground bushings.
   6. Provide a flexible bonding jumper for isolated metallic piping and ductwork and around expansion fittings and joints.

C. Size. Where grounding and bonding conductors are not sized on Drawings, size the grounding conductors in accordance with NEC Table 250.122. Size bonding jumper so that minimum cross-sectional area is greater than or equal to that of the equivalent grounding conductor as determined from NEC Table 250.122.

D. Taps, Splices and Connections: Make grounding (earth) conductor approximately 2 inches longer than the ungrounded (phase) conductors at both ends.
3.5 FIELD QUALITY CONTROL

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

B. Testing: Test the completed grounding system by fall-of-potential method. Measure ground resistance from system grounding electrode main conductors to convenient ground reference point using suitable ground testing equipment.
   1. Prepare test procedures and test forms to be used for field testing of completed grounding system. Procedures and forms shall include documentation of test equipment proposed for use in field testing of completed grounding system.
   2. Resistance shall not exceed 1 ohm.
   3. Testing points shall include measurement of ground resistance from system neutral at electrical service entrance to convenient ground reference point using suitable ground testing equipment.
   4. Where measured resistance to ground exceeds 1 ohm, add additional ground rods to grounding system to achieve system resistance to ground of 1 ohm or less, and document measured resistance to ground after ground rods are added. Repeat as required to achieve resistance to ground of 1 ohm or less, at no additional cost to Owner.

C. Documentation: Submit report of field testing of completed grounding system to Architect/Engineer and to Owner’s Representative.

3.6 CONFLICTS

A. In the event a conflict exists between this specification and the referenced standards, the requirements of this specification shall be regarded as secondary.

END OF SECTION
SECTION 26 0529
METAL FRAMING AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY
   A. This Section specifies the furnishing and installation of metal framing, including channels, fittings, clamps, hardware, electrical accessories and brackets.

1.2 SUBMITTALS
   A. None required.

PART 2 - PRODUCTS

2.1 MATERIALS
   A. Make channels, fittings, clamps, electrical accessories and brackets of sheet steel or of malleable cast iron. Fabricate threaded fasteners of carbon steel.

2.2 COATINGS
   A. Hot-dip galvanize all steel components utilized indoors. Provide stainless steel framing for outdoor applications.

2.3 SIZES
   A. Provide channels fabricated from not less than 12-gage sheet steel, 1-5/8 inches wide and not less than 1-5/8 inches deep.

PART 3 - EXECUTION

3.1 APPLICATION
   A. Hot-dip galvanized steel shall be used in all areas except use stainless steel components when exposed to the weather, in the crawl space and when located in a corrosive atmosphere.

3.2 SUPPORTS
   A. Provide metal framing to support large or heavy wall-mounted equipment, wall-mounted raceways and ceiling-hung raceways. Use stainless steel channel to mount the exhaust fan
disconnect switches on the roof. Supports shall be mounted independent of the fan enclosure. Secure support to roof.

3.3 ANCHOR BOLTS

A. Powder actuated anchors are not approved for use in existing slabs. Provide screw type anchors or expansion anchors; size to support the load.

B. Space bolts a maximum of 24 inches on center, with not less than two bolts per piece of framing.

3.4 TOUCH-UP

A. Touch up all scratches or cuts on steel components with an approved zinc chromate or a 90 percent based zinc paint.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY
   A. This Section specifies the furnishing and installation of electrical raceway systems.

1.2 REFERENCE STANDARDS
   A. ANSI/ANSI C80.1 - Rigid Steel Conduit - Zinc-Coated.
   B. ANSI/ANSI C80.3 - Electrical Metallic Tubing - Zinc-Coated.
   C. ANSI/UL 1 - Flexible Metal Conduit.
   D. ANSI/UL 5 - Surface Metal Raceways and Fittings.
   E. ANSI/UL 360 - Liquid-tight Flexible Steel Conduit.
   F. ANSI/UL 467 - Electrical Grounding and Bonding Equipment.
   G. ANSI/UL 651 - Schedule 40 and 80 Rigid PVC Conduit.
   H. ANSI/UL 797 - Electrical Metallic Tubing.
   I. ANSI/UL 870 - Wireways, Auxiliary Gutters and Associated Fittings.
   J. NEMA VE 1 - Metallic Cable Tray Systems.
   K. NEMA TC-6 and 8 – EB Underground Conduit
   L. UL 6 - Rigid Metal Conduit.

1.3 SUBMITTALS
   A. Surface metal raceways and fittings.
2.1 CONDUIT AND FITTINGS

A. Rigid Metal Conduit.
   2. Fittings. Threaded steel or malleable iron, either cadmium plated or hot-dipped galvanized.

B. Electrical Metallic Tubing (EMT).
   2. Fittings. Steel set screw fittings, either cadmium plated or hot-dipped galvanized. Connectors shall have insulated throat bushings. Provide double set screw for 1 ½” conduit and over.

C. Rigid Nonmetallic Conduit.
   2. Fittings. Solvent weld socket type.
   3. EB and DB PVC conduit is not permitted.

D. Flexible Metal Conduit.
   2. Fittings. One-screw and two-screw for 1-1/2 inches and larger, double-clamp steel or malleable iron, either cadmium plated or hot-dipped galvanized.

E. Liquid-tight Flexible Steel Conduit.
   1. Conduit. Spiral-wound, square-locked, hot-dipped galvanized steel strip plus a bonded outer jacket of PVC.
   2. Fittings. Compression type, malleable iron, with insulated throat, either cadmium plated or hot-dipped galvanized.

F. Elbows.
   1. Provide large radius elbows.

G. Sealing Fittings: Where conduit sealing fittings are required, they shall be of malleable iron, copper-free cast aluminum, ferroalloy, or other suitable construction. Provide wide fill fitting to facilitate insertion of sealing compound. Provide fitting closures, unions, and adapters of the same manufacturer that are compatible with the selected sealing fitting.
   1. Orientation: Unless specifically noted otherwise, provide conduit sealing fittings suitable for installation in both horizontal and vertical raceways.
   2. Combination Drain/Seal Fitting. Where drain/sealing fittings are required, they shall be of malleable iron construction with an internal drainage path which provides a visual means to ensure that the compound chamber is properly filled. The installation shall enable the drain/breather fitting and filler plug to be installed immediately after the sealing compound is poured.
   3. Finish: Hot dipped galvanized.
   4. Compound: Provide sealing compound compatible with the specified sealing fitting, and in compliance with the requirements of NEC-501.15(C).
   5. Listing: UL 886.
   6. Use: In classified locations per NEC-501.15 and NEC-502.15 and in conduits that breech the envelope of spaces that are classified with a Bio-Safety Level greater than BSL 1.
7. Manufacturer:
   a. Appleton.
   b. Crouse-Hinds/Cooper.
   c. O-Z/Gedney.

2.2 WIREWAYS

A. Material. Not less than 16-gage sheet steel.

B. Dimensions. Cross section dimensions not less than 4 inches by 4 inches.

C. Finish. Not less than two coats of enamel over a rust-inhibiting prime coat.

D. Type.
   1. Indoors. NEMA 1.

2.3 SURFACE RACEWAYS AND FITTINGS

A. Provide two compartment aluminum raceway for locations requiring both power and data. Provide Hubbell HBLALU5000 series or approved equal.

B. Provide single compartment aluminum raceway for locations requiring power only. Provide Hubbell HBLALU2000 series or approved equal.

PART 3 - EXECUTION

3.1 CONDUIT AND FITTINGS

A. Minimum Trade Size. 3/4 inch, except that 1/2-inch flexible metal conduit may be used in lengths not exceeding 72 inches for tap conductors supplying lighting fixtures.

B. Types According to Use.
   1. Use hot dipped galvanized rigid steel conduit (RGS) outside above ground where exposed to weather and other non-conditioned spaces such as crawl spaces.
   2. Use EMT in interior walls or ceiling spaces and where exposed in open work areas, mechanical rooms or electrical rooms. Conduit that enters or leaves the top of panelboards or enclosures may be EMT, provided such panelboards and enclosures are located in mechanical or electrical rooms.
   3. Conduits may not be embedded in slabs without approval of the owner and the structural engineer.
   4. Use rigid nonmetallic conduit encased in concrete with minimum 3-inch-thick walls, where installed below grade. Concrete encasement may be omitted when conduit is used for site lighting circuits. Use Schedule 40 PVC. All horizontal to vertical transitions shall be made using RGS elbows RGS conduit stub-ups. Seal all conduits weather tight.
   5. Connect all indoor electrical equipment subject to vibration or movement with flexible metal conduit 24 inches minimum length. Where the equipment is located in a duct or plenum used for environmental air, the length of conduit shall not exceed 6 feet and the conduit shall be flexible metal conduit. Where the equipment is located outdoors or exposed to water, liquid-tight flexible metal conduit shall be used. Request approval of flexible metal conduit prior to installation.
6. Transitions.  
   a. Continue the heavier, more protective type conduit application not less than 4 inches into the area where lighter, less protective type conduit is permitted.

C. Preparation. Place sleeves in walls and floor slabs for the free passage of cables or conduits. Set sleeves in place a sufficient time ahead of concrete placement so as not to delay the work. Seal all openings and voids around sleeves through floors and walls. Be sure that plugs or caps are installed before concrete placement begins.

D. Installation Requirements.  
1. Metallic conduits must be continuous between enclosures such as outlet, junction and pull boxes, panels, cabinets, motor control centers, etc. The conduit must enter and be secured to enclosures so that each system is electrically continuous throughout. Where knockouts are used, provide double locknuts, one on each side. For EMT terminations, provide insulated throat bushings and on rigid metallic conduits, provide nonmetallic insulating bushings for conductor protection. Where feeder conduits, 1-1/2 inches and larger, terminate in equipment having a ground bus, such as in switchgear, motor control centers and panelboards, provide conduit with an insulated grounding bushing and extend a suitable grounding wire to the ground bus.
2. Have rigid nonmetallic conduit adequately solvent welded at joints to form a tight, waterproof connection.
3. Run concealed conduit as directly and with the largest radius bends as possible. Run exposed conduit parallel or at right angles to building or other construction lines in a neat and orderly manner. Conceal conduit in finished areas. Unless otherwise shown, remaining conduit may be exposed. Provide chrome-plated floor and ceiling plates around conduits exposed to view and passing through walls, floors, partitions, or ceilings in finished areas. Select properly sized plates to fit the conduit when securely locked in place.
4. Do not install conduits horizontally in partitions, walls or building slabs.
5. Empty Raceway. Refer to Division 27 telephone/data and Division 28 security specifications for cabling requirements. Provide empty raceway systems per ANSI/TIA-569-C.

E. Installation Methods.  
1. Install each entire conduit system complete before pulling in any conductors. Clean the interior of every run of conduit before pulling in conductors to guard against obstructions and conduit omissions.
2. Cut all joints square, then thread and ream smooth. Coat cuts, threads or scratches on steel conduit with an approved zinc chromate or with a 90 percent based zinc paint. When dry, draw up tight.
3. Make bends with minimum 24” radius. Make field bends using equipment designed for the particular conduit material and size involved. Bends must be free from dents or flattening. Use no more than the equivalent of four 90-degree bends in any run between terminals and cabinets, or between outlets and junction boxes or pull boxes.
4. Conduit bodies may be used in lieu of conduit ells where ease of installation and appearance warrants their use. Conduit bodies larger than 1 inch may be used only where approved.
5. Securely fasten and support conduit to structure or metal framing using hot-dipped galvanized, malleable iron pipe straps or other approved means. Wires of any type may not be used for securing conduits. Branch circuit raceways which are 1 inch or smaller may be attached to wall studs by use of manufactured clips.
6. Provide a No. 30 nylon pulling line in conduits in which wiring is not installed under this work. Identify both ends of the line by means of labels or tags reading “Pulling Line - Telephone,” etc.
7. Suitably cap conduit during construction to avoid water, dirt and trash entrance.
8. Use expansion-deflection fittings on conduit crossing structural expansion joints and on exposed conduit runs where necessary. Provide bonding jumpers across fittings in metal raceway systems.

9. Use expansion fittings in conduit that terminates at sensitive equipment.

10. With a coupling, terminate concealed conduit for future use at structural surfaces. Install a pipe plug flush with the surface.

11. Openings around electrical penetrations of fire-resistance rated walls, partitions, floors or ceilings shall be firestopped to maintain the fire resistance rating using approved methods.

F. Sealing Fittings.

1. General: Where conduit sealing fittings are required, provide combination drain/sealing fittings unless specifically indicated otherwise on drawings.

2. Provide sealing fittings compatible with the specified raceway system. Sealing fittings shall be suitable for the conduit orientation at which the seal is to be applied, either horizontal or vertical.

3. Provide sealing fittings suitably sized for the conductor fill in the selected conduit. Conductor fill shall not exceed 25 percent of the cross-sectional area of a rigid-metal conduit of the same trade size unless the sealing fitting is specifically identified for a higher percentage fill. Provide listed conduit reducers and couplings as required, and in accordance with the requirements of the NEC.

4. Provide sealing compound and fiber dam compatible with the specified sealing fitting and in compliance with the NEC.

5. Install sealing fittings, fiber dam, and sealing compound in accordance with manufacturer’s instructions and the requirements of the NEC. Provide depth of sealing compound equal to trade size of sealing fitting, minimum depth 5/8-inch.

Grounding: Where used for feeder circuits, motor branch circuits, and branch circuits for equipment, receptacles, or lighting, conduit shall also contain a grounding conductor which conforms to the requirements of the NEC. Where grounding conductor size is indicated in excess of the minimum requirements of the NEC, provide the larger size as indicated.

3.2 WIREWAYS

A. Install wireways, where shown, according to NEC Article 376. Field apply a 90 percent zinc paint coating over cuts or scratches before any other finish is applied.

3.3 SURFACE RACEWAYS

A. Install surface raceways, where shown, according to NEC Article 300. Securely ground raceway and fittings. Provide bushings at raceway entrances. Raceways shall be two compartment, top for receptacles and bottom for data. Provide power conduit and wiring as shown on plans. Provide 1-1 ¼" conduit from data compartment to cable tray. Conduit shall terminate in a flush mounted box at surface raceway location. Provide a 2” nipple between the box and the back of the surface raceway.

END OF SECTION
SECTION 26 0537

BOXES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies the furnishing and installation of outlet boxes, floor boxes, junction boxes and pull boxes.

1.2 REFERENCE STANDARDS

A. ANSI/NEMA Publication No. OS 1 - Sheet-steel Outlet Boxes, Device Boxes, Covers and Box Supports.

B. ANSI/UL 514A - Metallic Outlet Boxes.

C. ANSI/UL 514B - Fittings for Conduit and Outlet Boxes.

1.3 SUBMITTALS

A. Provide product data.

PART 2 - PRODUCTS

2.1 OUTLET BOXES

A. Flush Device Boxes. Provide galvanized steel boxes of sufficient size to accommodate wiring devices to be installed at outlet. Provide an extension ring for the device(s) to be installed. Square or rectangular boxes may be used. Unless otherwise noted, provide minimum 2-1/8-inch deep by 4-inch square minimum size box. For data outlets provide minimum 2-1/8-inch deep by 4-11/16 inch square minimum size box.

B. Exposed or flush Device Boxes. Provide FS or FD cast boxes for surface mounting in areas having exposed rigid metal conduit systems.

C. Boxes for Lighting Fixtures. Provide galvanized steel octagonal boxes with fixture stud supports and attachments as required to properly support ceiling and bracket-type lighting fixtures. Unless otherwise noted, provide 2-1/8-inch deep by 4-inch box.

D. Masonry Boxes. Provide galvanized steel, 3-1/2-inch deep, masonry boxes for all devices installed in masonry walls.

E. Switch Boxes. Not permitted.

F. Listing. UL 514.

BOXES 26 0537 - 1
G. Containment Areas (BSL 3):

H. Provide cast type boxes, suitable for embedding in masonry or concrete. Boxes with pre-punched knockouts are not acceptable in containment areas.

2.2 FLOOR BOXES

A. Box. See AV plans.

B. Cover. See AV plans.

C. Location. Specific floor box locations are indicated on the electrical and AV plans.

2.3 JUNCTION, PULL AND SPLICE BOXES

A. Construction. Provide galvanized steel boxes conforming to NEC Article 314.

B. Interior Spaces. Provide NEMA 1 type boxes at least 4 inches deep.

C. Exterior Spaces. Provide NEMA 4X type boxes at least 4 inches deep.

D. Embedded. Provide NEMA 4 cast iron type with flush flanged cover when cast in concrete.

E. Listing. UL 514.

PART 3 - EXECUTION

3.1 OUTLET BOXES

A. Flush Boxes. Unless otherwise indicated, mount all outlet boxes flush within 1/4 inch of the finished wall or ceiling line. Provide galvanized steel extension rings where required to extend the box forward in conformance to NEC requirements. Attach ring with at least two machine screws. Securely fasten outlet boxes. Provide plaster covers for all boxes in plastered walls and ceilings.

B. Fixture Boxes. Where boxes for suspended lighting fixtures are attached to and supported from suspended ceilings, adequately distribute the load over the ceiling support members.

C. Mounting Height. Mounting height of a wall-mounted outlet box means the height from finished floor to horizontal center line of the cover plate. Where outlets are indicated adjacent to each other, mount these outlets in a symmetrical pattern with all tops at the same elevation. Where outlets are indicated adjacent, but with different mounting heights, line up outlets to form a symmetrical vertical pattern on the wall. Verify the final location of each outlet with Owner's representative before rough-in. Remove and relocate any outlet box placed in an unsuitable location.

D. Back-to-Back Boxes. Do not connect outlet boxes back to back unless approval is obtained from the Owner's representative. Where such a connection is necessary to complete a particular installation, fill the voids around the wire between the boxes with sound insulating material.
E. Box Openings. Provide only the conduit openings necessary to accommodate the conduits at the individual location.

3.2 FLOOR BOXES

A. Verify locations of all floor boxes with the Owner's representative before installation. Completely envelope floor boxes in concrete except at the top. Increase slab thickness at boxes if required to obtain a minimum of 2 inches of concrete below bottom of box. Adjust covers flush with finished floor.

B. Where floor boxes are shown in the same location on AV, Telecommunication and Electrical drawings, combine all devices in one box.

3.3 JUNCTION AND PULL BOXES

A. Installation. Install boxes as required to facilitate cable installation in raceway systems. Provide a junction box for terminating of flexible metal conduit to light fixtures. In general provide boxes in conduit runs of more than 100 feet.

B. Covers. Provide boxes so that covers are readily accessible and easily removable after completion of the installation. Include suitable access doors for boxes above inaccessible ceilings. Select a practical size for each box and cover.

C. Colors. Refer to specification section 26 0553 - Electrical Identification.

END OF SECTION
SECTION 26 0553
ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 WORK INCLUDED
A. Nameplates and tape labels.
B. Wire and cable markers.
C. Conduit color coding and labeling.

1.2 REFERENCES
A. NFPA 70 – National Electrical Code (NEC).

1.3 SUBMITTALS
A. Provide submittals in accordance with and in additional to Section 26 0000, Electrical General Provisions, and Division 01, for submittal requirements.
   1. Furnish nameplate identification schedules to Owner’s Representative for review and acceptance, listing equipment type and nameplate data with letter sizes and nameplate material.
   2. Nameplate Schedules. Prior to fabrication of nameplates, furnish to Owner for review and acceptance a schedule of nameplates for electrical equipment. For each equipment and circuit identified, provide 4-line nameplate as follows:
      a. Line 1: Device designation, switchgear or MCC cubicle, switchboard circuit, etc. as indicated on plans, schematics, or schedule Drawings.
      b. Line 2: Leave blank for Owner’s use.
      c. Line 3: Source or voltage characteristics, as applicable.
      d. Line 4: Load served.
   3. Refer to Parts 2 and 3 of this Section for nameplate requirements.

PART 2 - PRODUCTS

2.1 MATERIALS
A. Equipment Nameplates:
   1. For normal power electrical equipment, provide engraved three-layer laminated plastic nameplates, engraved white letters on a black background.
   2. For emergency equipment, provide engraved three-layer laminated plastic nameplates with engraved white letters on a red background.
   3. For UPS powered equipment, provide engraved three-layer laminated plastic nameplates with engraved white letters on an orange background.
4. For fire alarm system, provide engraved three-layer laminated plastic nameplates with white letters on a yellow background.
5. For security and CCTV system panels, provide engraved three-layer laminated plastic nameplates with white letters on a blue background.
6. Nameplate minimum size shall be 1 inch high by 3 inches long with engraved white letters. Generally, the number and name shall be at least 1/4 inch high and other data at least 1/8 inch high.

B. Conductor Color Tape and Heat Shrink:
   1. Colored vinyl electrical tape shall be applied perpendicular to the long dimension of the cable or conductor.
   2. In applications utilizing tray cable, heat shrinkable tubing shall be used to obtain the proper color coding for the length of the conductor in the cabinet or enclosure. Variations to the cable color coding due to standard types of conductor or cables are not acceptable.

C. Warning labels: Provide warning labels with black lettering on red background with a minimum of 1/2 inch lettering.

D. Tape Labels: Provide device labels of plastic adhesive tape, with minimum 1/4-inch letters for labeling receptacles, switches, control device stations, junction and pull boxes and manual motor starter units, etc.
   1. Normal power. Black letters on clear background. Provide white letters on black background where specifically indicated on Drawings or specified in other Sections.
   2. Emergency/standby power. Red letters on clear background. Provide white letters on red background where specifically indicated on Drawings or specified in other Sections.
   3. UPS power. Orange letters on clear background. Provide white letters on orange background where specifically indicated on Drawings or specified in other Sections.
   4. Provide device label with black letters, one half inch wide tape with one quarter inch high letters, minimum.
   5. Manufacturer. Brother type “P-Touch”, or accepted substitution.

E. J-Box and Cover plate Voltage Labels: Black stenciled letters 1/4 inch high. Adhesive back tapes may be used if a clear tape is applied over the label for protection.

PART 3 - EXECUTION

3.1 PRODUCT DELIVERY, STORAGE AND HANDLING
   A. Deliver materials in individually wrapped factory-fabricated fiberboard-type containers.
   B. Store materials in a clean and dry space, elevated above grade, and protected from weather and sunlight.
   C. Handle materials carefully to avoid damage, breaking, denting and storing. Damaged materials shall be rejected and shall not be installed.

3.2 INSTALLATION
   A. Degrease and clean surfaces to receive nameplates or tape labels.
B. Install nameplates parallel to equipment lines.

C. Secure plastic nameplates to equipment fronts using stainless steel self-tapping screws or rivets. Use of adhesives shall be per Owner’s approval. Stick-on or adhesives will not be allowed unless the NEMA enclosure rating is compromised, then only epoxy adhesive shall be used to attach nameplates. Secure nameplate to outside face of flush mounted panelboard doors in finished locations.

D. Designations: Externally mark equipment, feeders, branch circuits and similar items with nameplates with the same designations as indicated on the Drawings.

3.3 WIRE AND CONDUCTOR IDENTIFICATION

A. Provide wire markers on each conductor in panelboard gutters, pull boxes, outlet and junction boxes, ground busbars and at load connection.
   1. Identify with branch circuit or feeder number for power and lighting circuits.
   2. Label control conductor with number as indicated on schematic and interconnection diagrams or equipment manufacturer's shop drawings for control wiring.
   3. Label grounding conductors at ground busbars, electrical equipment, and test wells with metal tags indicating the cable purpose and point of termination at opposite end of cable. Securely fasten metal tags along the length of the grounding cable or conductor. Place metal tags to avoid creating short circuits, inadvertent grounding paths, or other contact with grounded or energized terminals, conductors, or components.

B. Existing Facilities. Where the Contractor encounters conductor identification in existing electrical distribution systems different from the colors scheduled in this Section, notify the Owner’s Representative in writing and propose a resolution, in accordance with the requirements of Part 1 of Section 26 0000, Electrical General Provisions.

C. Conductors for power and lighting circuits shall be identified per the following schedule.

<table>
<thead>
<tr>
<th>Conductor</th>
<th>208/120V</th>
<th>480/277V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase A</td>
<td>Black</td>
<td>Brown</td>
</tr>
<tr>
<td>Phase B</td>
<td>Red</td>
<td>Purple</td>
</tr>
<tr>
<td>Phase C</td>
<td>Blue</td>
<td>Yellow</td>
</tr>
<tr>
<td>Neutral</td>
<td>White</td>
<td>Gray</td>
</tr>
<tr>
<td>Grounding</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Isolated Ground</td>
<td>Green w/Yellow Tracing Stripe</td>
<td>N/A</td>
</tr>
</tbody>
</table>

D. Where more than one conductor of the same phase or more than one neutral or ground conductor occurs at the same outlet or junction box, these conductors shall be identifiable from each other by use of stripes or distinguishing markings. The neutral tracer color shall match the phase conductor color with which it is associated.

E. Switch leg conductors. Pink.
   1. The color of switch leg conductors shall be pink, marked with tape matching the color of the associated branch circuit phase conductors.
F. Low voltage wiring systems. Conductors for low voltage circuits shall be identified as follows.
   1. Fire Alarm. Red
   2. Security. Blue and Yellow. Coordinate wiring color with Division 27 and telecommunications supplier
   3. Clock. Green and White
   4. Telephone. White. Coordinate wiring color with Division 27 and telecommunications supplier.
   5. Data. Bright Blue. Coordinate wiring color with Division 27 and telecommunications supplier.
   6. HVAC Controls. Dark Blue. Coordinate wiring color with Division 23 and controls supplier.

3.4 NAMEPLATES
   A. Provide nameplates of minimum letter height as scheduled below. Nameplates shall be same
      as equipment names indicated on the Drawings.
      1. Externally mark electrical equipment with nameplates identifying each and the equipment
         served.
      2. Supply blank nameplates for spare units and spaces.
   B. Nameplate Fasteners. Fasten nameplates to the front of equipment by means of stainless steel
      self-taping screws. Stick-on or adhesives are not allowed unless the NEMA enclosure rating is
      compromised, then use only epoxy adhesive to attach nameplates.
   C. Individual Circuit Breakers in Distribution Panelboards, Disconnect Switches, Motor Starters,
      and Contactors: 1/4 inch: identify source to device and the load it serves, including location.
   D. Dry Type Transformers Not in Substations: 3/8 inch: identify equipment designation. 1/4 inch:
      identify primary and secondary voltages, primary source, and secondary load and location.
   E. Panelboards: 3/8 inch: identify equipment designation. 1/4 inch: identify source, voltage and
      bus rating.
   F. Provide complete circuit directory for each new panel board. Provide complete circuit directory
      for each existing panelboard with circuits added, removed, demolished, moved, renovated, or
      otherwise altered as part of this project or as work required by or incidental to this project. Refer
      to Section 26 2416, Panelboards – Distribution and Branch Circuit for directory requirements.
   G. Identification tags on items in finished areas, such as special switches, etc., shall be securely
      attached on, or in the immediate vicinity, of the item. Supply blank nameplates for spare units
      and spaces.

3.5 ENCLOSURE COLOR CODING
   A. The following systems shall have each enclosure and cover completely painted as follows:
      1. Fire Alarm. Red, with black “FA” text.
B. The following systems shall have each junction and pull box cover completely painted per the following:

<table>
<thead>
<tr>
<th>System</th>
<th>Color of Box Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethernet Backbone</td>
<td>Blue</td>
</tr>
<tr>
<td>Telecommunications</td>
<td>Brown</td>
</tr>
<tr>
<td>FCMS</td>
<td>Green</td>
</tr>
<tr>
<td>Emergency Power</td>
<td>Red, with black “E” text</td>
</tr>
<tr>
<td>Security**</td>
<td>White</td>
</tr>
<tr>
<td>Fire Alarm</td>
<td>Red, with black “FA” text</td>
</tr>
<tr>
<td>Clock</td>
<td>Fluorescent Violet</td>
</tr>
</tbody>
</table>

**Security shall include, but not be limited to, the following systems:
- Card Access
- Duress Alarms
- Perimeter Door Alarms
- CCTV

3.6 EQUIPMENT AND DEVICE MARKING

A. Pull, Junction and Outlet Boxes.
1. Electrical systems shall be identified with yellow paint.
2. With 1/2-inch high permanent lettering, identify conduits connected to pull, junction and outlet boxes with the complete circuit number of the conductors contained therein. Identify complete circuit numbers on box cover and on the conduit.
3. Where multiple circuits are contained in a box, identify the circuit conductors with permanent tags which indicate circuit designation. Identify both phase and associated neutral conductors.
4. Boxes and covers containing emergency power or emergency lighting circuits shall be painted red. Factory finish is acceptable in lieu of painting in the field.
5. Fire alarm boxes and covers shall be painted red. Using permanent lettering, identify box cover as “F/A” or “FAS”, with fire alarm zone served. Factory finish is acceptable in lieu of painting in the field.

B. Electrical Raceways shall be painted yellow. Surface metal raceway in laboratories shall not be painted.

C. Power Receptacles: Use a clear plastic tape label, nameplate or engraved device plate to identify power receptacles where the nominal voltage between a pair of contacts is greater than 150 volts with circuit number, voltage and phases. If nameplates are used, attach to wall directly above device plate. Nominal 120 volt power receptacles shall be labeled with the complete circuit number.

D. Snap Switches:
1. Where the equipment served is not in sight of the snap switch, or where snap switch controls dedicated outlets or special equipment, provide a clear plastic tape label or an engraved switch plate to identify equipment served.
2. Where snap switches are grouped together, provide clear plastic tape labels or engraved switch plates to identify non-lighting equipment served.
E. Dedicated Outlets: For dedicated outlets, provide a clear plastic tape label or an engraved coverplate indicating the equipment served. Dedicated is understood to be specific equipment listed by equipment number in the panel schedules or identified on the plans. Dedicated also includes computer outlets.

F. Remote Ballasts: For remote ballasts not within five feet of their luminaire, provide appropriate permanent lettering on both the ballasts and the luminaire to identify which units are mated to the other.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. Provide a complete short-circuit and protective device coordination study for the normal and emergency/standby power electrical distribution systems. The extent of the study shall be from the Utility transformer.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in the latest edition of NFPA 70E - Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in the latest edition of NFPA70E, Annex D. The arc flash study shall encompass all normal and emergency/standby power electrical distribution systems.

1.2 SUBMITTALS

A. A preliminary short-circuit study shall be submitted to the design engineer either before or at the same time as the equipment submittals. If equipment submittals such as switchgear, switchboards, panelboards etc. are submitted without a preliminary study, they will be returned Rejected.

B. The results of the short-circuit protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. The report shall include the following sections:
   1. Executive Summary.
   2. Descriptions, purpose, basis and scope of the study.
   3. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties.
   4. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, fuse selection.
   5. Fault current calculations including a definition of terms and guide for interpretation of the computer printout.
   6. Details of the incident energy and flash protection boundary calculations.
   7. Recommendations for system improvements, where needed.
   8. One-line diagram.

C. Arc flash labels shall be provided for all equipment described in paragraph 2.04.

1.3 REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.

B. American National Standards Institute (ANSI):
1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.

C. The National Fire Protection Association (NFPA)

1.4 QUALIFICATIONS

A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Licensed Professional Electrical Engineer licensed in the State of Texas and skilled in performing and interpreting the power system studies.

B. The Licensed Electrical Engineer shall be a full-time employee of the equipment manufacturer or an approved engineering firm and have a minimum of five (5) years of experience in performing power system studies. In addition, the licensed engineer shall be based and work in the State of Texas.

1.5 COMPUTER ANALYSIS SOFTWARE

A. The studies shall be performed using the latest revision of EDSA, SKM Systems Analysis Power Tools or ETAP.

PART 2 - PRODUCTS

2.1 DATA COLLECTION

A. The Contractor shall be responsible for collecting all data for the studies.

2.2 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

A. Provide the following:
1. Calculation methods and assumptions.
2. Selected base per unit quantities.
3. One-line diagram of the system being evaluated.
4. Source impedance data, including electric utility system and motor fault contribution characteristics.
5. Tabulations of calculated quantities.
6. Results, conclusions, and recommendations.
7. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a line to ground fault at each piece of equipment/bus as described in 1.01.

B. Protective Device Evaluation:
1. Evaluate equipment and protective devices and compare to short circuit ratings.
2. Adequacy of all equipment to withstand short-circuit stresses.


D. Transformer design impedances shall be used only when test impedances are not available.

2.3 PROTECTIVE DEVICE COORDINATION STUDY

A. Proposed protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs. The phase curves shall be plotted on separate sheets from the ground fault curves.

B. Plot the following characteristics on the TCC graphs where applicable:
   1. Equipment name based on Bid documents.
   2. Electric utility’s overcurrent protective device.
   3. Medium voltage overcurrent relay settings.
   4. Medium and low voltage fuses including manufacturer’s minimum melt, total clearing, tolerance, and damage bands.
   5. Low voltage (480V and below) equipment circuit breaker trip device settings, including manufacturer’s tolerance bands.
   6. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
   7. Ground fault protective devices, as applicable.
   8. Pertinent motor starting characteristics and motor damage points, where applicable.
   9. Pertinent generator short-circuit decrement curve and generator damage point.

C. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.4 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584-2002 equations that are presented in the latest edition of NFPA 70E, Annex D.

B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, motor-control centers, panelboards, and splitters) where work could be performed on energized parts.

C. The Arc-Flash Hazard Analysis shall include all electrical equipment.

D. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm2.
E. The results of the short circuit calculations (fault values) and protective device coordination study (device clearing times) shall be utilized for use by the arc flash program. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.

F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating.

G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:
   1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.
   2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).

H. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

J. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

2.5 REPORT SECTIONS

A. Input data shall include, but not be limited to the following:
   1. Feeder input data including feeder type (cable or bus), size, length, number per phase, conduit type (magnetic or non-magnetic) and conductor material (copper or aluminum).
   2. Transformer input data, including winding connections, secondary neutral-ground connection, primary and secondary voltage ratings, KVA rating, impedance, % taps and phase shift.
   3. Reactor data, including voltage rating, and impedance.
   4. Generation contribution data, (synchronous generators and Utility), including short-circuit sub-transient reactance (X”d), rated MVA, rated voltage, three-phase and single line-ground contribution (for Utility sources) and X/R ratio.
5. Motor contribution data (induction motors and synchronous motors), including short-circuit reactance, rated horsepower or kVA, rated voltage, and X/R ratio.

B. Short-Circuit Output Data shall include, but not be limited to the following reports:
   1. Low Voltage Fault Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
      a. Voltage.
      b. Calculated fault current magnitude and angle.
      c. Fault point X/R ratio.
      d. Equivalent impedance.
   2. Momentary Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
      a. Voltage.
      b. Calculated symmetrical fault current magnitude and angle.
      c. Fault point X/R ratio.
      d. Calculated asymmetrical fault currents:
         1) Based on fault point X/R ratio.
         2) Based on calculated symmetrical value multiplied by 1.6.
         3) Based on calculated symmetrical value multiplied by 2.7.
      e. Equivalent impedance.
   3. Interrupting Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
      a. Voltage.
      b. Calculated symmetrical fault current magnitude and angle.
      c. Fault point X/R ratio.
      d. No AC Decrement (NACD) Ratio.
      e. Equivalent impedance.
      f. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a symmetrical basis.
      g. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a total basis.

C. Recommended Protective Device Settings:
   1. Phase and Ground Relays:
      b. Current setting.
      c. Time setting.
      d. Instantaneous setting.
      e. Recommendations on improved relaying systems, if applicable.
   2. Circuit Breakers:
      a. Adjustable pickups and time delays (long time, short time, ground).
      b. Adjustable time-current characteristic.
      c. Adjustable instantaneous pickup.
      d. Recommendations on improved trip systems, if applicable.

D. Incident Energy and Flash Protection Boundary Calculations:
   1. Arcing fault magnitude.
   2. Protective device clearing time.
   3. Duration of arc.
   4. Arc flash boundary.
   5. Working distance.
   6. Incident energy.
   8. Recommendations for arc flash energy reduction.
PART 3 - EXECUTION

3.1 FIELD ADJUSTMENT

A. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

3.2 ARC FLASH WARNING LABELS

A. The contractor of the Arc Flash Hazard Analysis shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.

B. All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.

C. The label shall include the following information, at a minimum:

1. Location designation.
2. Nominal voltage.
3. Flash protection boundary.
5. Incident energy.
7. Engineering report number, revision number and issue date.

D. Labels shall be machine printed, with no field markings.

E. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings. See page 6 for example of arc flash label.

1. For each 480V and 208V panelboard, one arc flash label shall be provided.
2. For each motor control center, one arc flash label shall be provided for each section.
3. For each low voltage switchboard, one arc flash label shall be provided for each section.
4. For each low and medium voltage switchgear, one flash label shall be provided for each breaker.
5. For medium voltage switches one arc flash label shall be provided.

F. Labels shall be field installed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

3.3 ARC FLASH TRAINING

A. The contractor of the Arc Flash Hazard Analysis shall train the owner’s qualified electrical personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours). The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET) or equivalent.
**DANGER**

**Bus Electrical Shock and Arc Flash Hazard**

*Appropriate PPE Required*

<table>
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<th>Danger</th>
<th>Max PPE Level</th>
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<tr>
<td>360.6</td>
<td>Cal/cm^2 Flash Hazard at 17.9 inches</td>
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<tr>
<td>52.4</td>
<td>kA Bolted Fault Current</td>
</tr>
<tr>
<td>863.8</td>
<td>inches Flash Hazard Boundary</td>
</tr>
</tbody>
</table>

| Shock Distances (inches) - Limited = 120.0, Restricted = 12.0, Prohibited = 1.0 |

| Volts Shock Hazard when cover is removed |

- **Glove Class** ✓ Insulated Tools
- **Suit Hood** ✓ Eye Protection
- **Non-melting Flame Resistant Hair/Beard Nets**

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<th>Required</th>
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<th>Not Allowed</th>
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<tbody>
<tr>
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<td>✓</td>
<td>x</td>
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</tbody>
</table>

Arc Flash boundary at energy < 1.2 cal/cm^2

**END OF SECTION**
SECTION 26 2416

PANELBOARDS – DISTRIBUTION AND BRANCH CIRCUIT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies the furnishing and installation of distribution and branch circuit panelboards. See 26 43 13 and one line diagrams for installation of surge protective device in distribution panelboards. The panelboard used for the main service shall be service entrance rated.

1.2 REFERENCE STANDARDS

A. ANSI/UL 50 - Cabinets and Boxes.
B. ANSI/UL 67 - Electric Panelboards.
C. ANSI/UL 508 - Industrial Control Equipment.
D. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
E. NEMA AB 3 - Molded Case Circuit Breakers and Their Application.
F. NEMA PB 1 - General Instructions for Proper Handling, Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

1.3 SUBMITTALS

A. Provide product data on panelboards, circuit breakers and remote control switches.
B. Provide shop drawings with a schedule for each panelboard that indicates the circuit breaker arrangement and other pertinent features. Panelboard schedules must be identical to the schedules in the project documents unless there is a technical reason for a deviation. Submitted panelboard schedules must also contain confirmation of panelboard characteristics.

PART 2 - PRODUCTS

2.1 ENCLOSURE

A. Cabinet. Construct cabinets in accordance with UL 50. Use not less than 16-gauge galvanized sheet steel. Provide a minimum 4-inch gutter wiring space on each side. Reinforce cabinets and securely support bus bars and over-current devices to prevent vibration and breakage in handling. Provide cabinets without conduit knockouts. All conduit knockouts shall be made in the field. Surface-mounted panelboards in finished spaces shall have cabinet finishes to match doors and trim as specified below. In unfinished areas such as mechanical and electrical...
rooms, galvanized sheet steel cabinets are sufficient, provided galvanizing occurs after components are cut or sheared.

B. Doors and Trim. Provide cabinets with door-in-door, dead-front construction. The outer door shall have a continuous piano hinge on the right side and shall provide access only to circuit breaker operating handles. The inner door shall allow for full access to the cabinet interior. Fabricate doors and trim of cold-rolled sheet steel. Equip inner doors with flush-type combination catch and key lock. Key all locks alike. Fasten trim for panelboards to cabinets by an approved means that permits both horizontal and vertical adjustment. Trim for surface-mounted panelboards must fit the cabinet with no overhang. Apply a finish to trim and doors consisting of two coats of enamel over a rust-inhibiting prime coat.

2.2 BUS

A. Fabricate phase, neutral and ground buses of 98 percent IACS conductivity copper with rounded edges. Size bars as indicated and brace them to withstand symmetrical short circuit current as indicated on drawings. Install buses in allotted spaces so that devices can be added without additional machining, drilling or tapping. Use buses with silver-plated contact surfaces. Include copper 200% neutral bus for 208Y/120V panelboards. This applies to all standard panels and electronic grade panelboards. Provide a ground bus rated as required. Provide an additional isolated ground bus where indicated on plans.

2.3 PROTECTIVE DEVICES

A. Provide circuit breakers for the specified service with the number of poles and ampere ratings indicated.

B. Provide breakers that are quick-make and quick-break on both manual and automatic operation. Use a trip-free breaker that is trip indicating. Incorporate inverse time characteristic by bimetallic overload elements and instantaneous characteristic by magnetic trip. Where indicated, provide ground fault circuit interrupters (GFCI). Main circuit breakers 400A and above in all panelboards shall be 100% rated. Main breakers below 400A and feeder breakers may be 80% rated. Provide electronic trip for feeder breakers 400A and larger; Long time, Short time and Instantaneous.

C. For 2-pole and 3-pole breakers, use the common-trip type so that an overload or fault on one pole will trip all poles simultaneously. Handle ties are not acceptable.

D. Unless otherwise indicated on plans, provide circuit breakers with the following interrupting ratings: 18,000 rms symmetrical amperes at rated voltage for breakers rated 277 volts, single pole or 480 volts, multipole and 10,000 rms symmetrical amperes at rated voltage for breakers rated 120V, single pole or 208 volts. Series rating of circuit breakers is not allowed. All circuit breakers shall be fully rated, unless indicated otherwise.

E. Connect breakers to the main bus by means of a solidly bolted connection. Use breakers which are interchangeable, capable of being operated in any position within the panel. Independently mount breakers so that a single unit can be removed from the front of the panel without disturbing or removing main bus, other units or other branch circuit connections.

F. Cable lugs shall suitable for copper or aluminum conductors.
2.4 CIRCUIT IDENTIFICATION

A. For each panelboard, provide a steel directory frame mounted inside the door with a heat-resistant transparent face and a directory card for identifying the loads served. Type directory as specified in Section 26 0000, paragraph 3.3.

2.5 LISTING

A. UL 67 - Electric Panelboards.

2.6 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers are Square D (BOD), Eaton Electrical (Cutler-Hammer), GE Company.

2.7 ELECTRONICS GRADE PANELBOARDS

A. Provide electronic grade panelboard for selected distribution and branch circuit panelboards. See plans. See Section 26 4313 for surge protective device.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards in the locations shown and as recommended in NEMA PB1.

B. Surface mounted panels shall be mounted to the wall utilizing 1 5/8" hot dipped galvanized framework. Do not mount panels directly to the wall.

3.2 MOUNTING HEIGHT

A. Install the panelboards 6' AFF to top of panelboard.

3.3 PROTECTION

A. Temporary Doors. Protect cabinets by a temporary door until the panelboard is energized. Temporary doors shall be 1/4-inch-thick plywood or equivalent rigid material. Temporary doors shall be installed when the cabinet is installed and shall remain closed at all times except when work is being performed inside the panelboard.

B. Permanent Doors and Trim. Permanent doors and trim shall be installed immediately before panelboards are energized. Permanent doors and trim shall be maintained in factory condition after installation. Doors shall remain closed at all times except when the panelboard is de-energized and work is taking place within the panelboard.
C. Cabinets. Cabinet interiors shall be maintained clean at all times. Cabinet exteriors shall be maintained free of mud, spray-on insulation, paint spray and all substances not placed on the exterior surface by the panelboard manufacturer.

END OF SECTION
SECTION 26 2726
WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY
   A. This Section specifies the furnishing and installation of wiring devices and device plates.

1.2 REFERENCE STANDARDS
   A. Americans with Disabilities Act (ADA).
   D. NEMA WD 1 - General Requirements for Wiring Devices.
   E. NEMA WD 2 - Semiconductor Dimmers for Incandescent Lamps.
   F. NEMA WD 5 - Specific-Purpose Wiring Devices.
   G. NFPA 70 - National Electrical Code (NEC).
   H. Texas Accessibility Standards (TAS).
   I. ANSI/UL 20 - General-Use Snap Switches.
   J. ANSI/UL 498 - Attachment Plugs and Receptacles.
   K. ANSI/UL 943 - Ground Fault Circuit Interrupters.
   L. UL 1449 - Transient Voltage Surge Suppressors.

1.3 RELATED WORK
   A. Section 26 0000, Electrical General Provisions.
   B. Section 26 0537, Boxes.
   C. Section 26 0553, Electrical Identification.
   D. Section 26 5100, Interior and Exterior Lighting.
1.4 SUBMITTALS

A. Provide product data on wiring devices and device plates.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide back- and side-wired, industrial-grade, factory-fabricated wiring devices in the type and electrical rating for the service indicated. Where type and grade are not indicated, provide proper selection to correspond with branch circuit wiring and overcurrent protection. Attachment of wires to devices shall be by screw pressure under the head of binding screws or by means of a factory made, listed, plug-style connector. Plug-style connector shall be touch safe while connected to branch circuit conductors and manufactured to mount at 90-degree angle to direction of insertion to allow easy mounting in outlet boxes. Arrangements depending on spring pressure or tension are not acceptable. All binding screws shall be brass or bronze.

B. Grade. Provide industrial-grade devices unless otherwise noted or specified.

C. Type. Provide straight-blade devices as specified herein and as indicated on Drawings. Provide locking-type receptacles (i.e., Twist-Lock) in corridors or other special type receptacles where indicated on Drawings.

2.2 WALL SWITCHES

A. Type. Quiet type, back and side wired switches as shown.

B. Rating. 20 amperes, 120/277 volts, unless indicated or specified otherwise.

C. Finished Areas. Wall switches shall be toggle-style switches. Select device plates of same color, and match with receptacle, phone and data outlet device plate style. Coordinate with Architect and Owner for room finish.


E. Manufacturers. The following designations are for white devices; provide devices in the color specified in paragraph 2.4, this Section.

<table>
<thead>
<tr>
<th>Type</th>
<th>Hubbell (BOD)</th>
<th>Cooper</th>
<th>Bryant</th>
<th>Pass &amp; Seymour</th>
<th>Leviton</th>
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<td>-L</td>
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</table>

1. Key operated switch: add the indicated suffix to the above designations.

F. Pilot light type shall be equipped with red toggle handle (glow when on), 20 amperes and 120/277 volt AC with number of poles as required.
G. Key operated switches shall be 20 amperes and 120/277 volt AC with number of poles as required. Key locks alike. Furnish keys compatible with key switch, quantity as directed by Owner, minimum of ten copies.

H. Switches for lighting circuits and motor loads under 1/3 hp shall be AC general use snap switch with toggle handle, 20 amperes and 120/277 volt AC with number of poles as required.

I. A listed manual switch having a horsepower rating not less than the rating of the motor, a thermal overload element suitable for the motor served, and marked “Suitable as Motor Disconnect”, shall be permitted to serve as the disconnect means for stationary motors of 1/4 horsepower or less.

J. Use horsepower rated switches, with thermal overload element, approved for motor control or disconnect service when controlling or disconnecting motor loads in excess of 1/4 hp. Horsepower rated switches shall be 30 ampere minimum, with number of poles as required.

K. EPO. Illuminated Emergency-Power-Off (EPO) switch shall be provided with button guard equal to Allen-Bradley #800T-QA10R or accepted substitution.

L. Switch terminal screws or connectors shall be designed to accommodate up to No. 10 AWG solid conductor.

2.3 RECEPTACLES

A. Type. Back and side wired receptacles.

B. Rating. As scheduled on Drawings.
   1. Dedicated circuit and convenience duplex receptacles shall be rated 20 amperes, 125 volt AC, where not scheduled or indicated otherwise on Drawings.
   2. Ground Fault Circuit Interrupter (GFCI or GFI). Refer to paragraph 2.3F, this Section.


D. Manufacturers. The following designations are for white devices or manufacturer’s standard device color; provide devices in the color specified in Article 2.4, this Section. Other manufacturers equal in design and function will be considered upon submittal of manufacturer’s data.

<table>
<thead>
<tr>
<th>NEMA Config.</th>
<th>Cooper</th>
<th>Bryant</th>
<th>Pass &amp; Seymour</th>
<th>Hubbell</th>
<th>Leviton</th>
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<td>GFR83FT</td>
<td>2094-W</td>
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E. Heavy Duty Locking-Blade Receptacles. NEMA WD 5. Locking-blade receptacles shall be heavy duty specification grade.

F. Ground Fault Circuit Interrupter (GFCI). GFCI receptacles shall be rated 20 amperes, 125 volt with integral ground fault current interrupter.
   1. End of Life. GFCI receptacles shall include End-of-Life protection, such that when the GFCI device is incapable of passing the internal self-test function, and can therefore no longer provide ground fault protection, the GFCI receptacle will either render itself incapable of delivering power, or indicate by visual or audible means that the device must be replaced.
2. Reverse Line-Load Mis-wire. GFCI receptacles shall include reverse line-line protection, such that the GFCI device will deny power to the receptacle face if it is mis-wired with the connections to the line and load terminals reversed.


4. Do not use feed through feature.

5. GFCI receptacles are required throughout the building within 6 feet of sinks, including lab areas.

6. Each GFCI device shall control only one receptacle.

7. Where receptacle is installed in damp or wet locations provide weather resistant type GFCI receptacles.

G. Specific-use receptacles shall have volts, amps, poles, and NEMA configuration as noted on Drawings.

H. Weatherproof Receptacles. Receptacles specified or indicated as “weatherproof” shall be mounted in a cast steel box with gasketed, weatherproof device plate as specified. Provide weatherproof, gasketed device covers suitable for continuous connection of cord-and-plug devices. See paragraph 2.5E, this Section.

I. Automatic Controlled Receptacle.
   1. All nonlocking-type, 125 volt, 15 and 20 ampere receptacles that are controlled by an automatic control device or incorporate control features that remove power from the outlet for the purpose of energy management or building automation shall be marked with the symbol indicated in paragraph 2.3.I.2 of this Section placed on the controlled receptacle outlet where visible after installation.
   2. Receptacle identifier:

2.4 DEVICE COLOR

A. Supply wiring devices in white, except where device color is specified or scheduled on Drawings, and as noted below:
   1. Wiring devices connected to emergency power shall be red.
   2. Isolated ground receptacles shall be orange.
   3. Key operated switches shall be gray.
   4. Automatic controlled receptacles shall be blue with blue cover plate.

B. Coordinate color of devices and device plates with the architectural finish for that room or area. Refer to architectural Drawings and specifications. Verify color and finish with Architect and Owner’s Representative.

C. For renovation or expansion of existing facilities, provide devices and plates to match existing finishes, devices, and device plates.

2.5 DEVICE PLATES

A. Finished Spaces.
   1. Provide high abuse and impact resistant nylon device plates, with cutouts as required for devices indicated on Drawings. Edges of plates must be flush with edges of boxes.

B. Color.
   1. Device plates for receptacles connected to emergency power shall be red.
2. Device plates for receptacles connected to normal power shall be white.
3. Where not specified or indicated otherwise, provide device plates in white.

C. Where switches or outlets are shown adjacent to each other, they shall be ganged with partitions between different type services and covered by a single custom wall plate.

D. Jumbo plates are not permitted.

E. Weatherproof enclosures.
1. For each GFCI receptacle specified in 2.3F and installed in wet locations, provide a weatherproof enclosure cover per NEC 406.9B(1) (Leviton 5977 DGR).

F. Exposed Boxes in Dry Interior Spaces. Make plates of heavy cadmium-plated sheet steel. Edges of plates must be flush with edges of boxes. Screws and fasteners shall be stainless steel.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

A. Deliver wiring devices individually wrapped in factory-fabricated containers.

B. Handle wiring devices carefully to avoid breaking, scoring, and damage to material components, enclosure and finish. Damaged products shall be rejected and not be installed on this project.

C. Store wiring devices in a clean, dry space, elevated above grade, and protected from weather, dirt, sunlight, and moisture.

D. Refer to paragraph 3.2 of Section 26 0000, Electrical General Provisions.

3.2 INSPECTION

A. Examine the areas and conditions under which wiring devices are to be installed and notify the Owner and the Architect/Engineer in writing of conditions detrimental to the proper and timely completion of the work. Include a written plan for correction of deficiencies and conditions noted. Inspect devices for physical damage. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.3 DEVICE COORDINATION

A. Where items of equipment are provided under other Sections, by other Divisions, or by the Owner, provide a compatible receptacle and device plate for the cap or plug, and cord of the equipment.

3.4 GENERAL

A. Install wiring devices in accordance with applicable requirements of the NEC, NEMA, ANSI, and the product manufacturer recommendations.
B. Taps, Splices and Connections. Make grounding (earth) conductor approximately 2 inches longer than the ungrounded (phase) conductors at both ends. Refer to Section 26 0526, Grounding and Bonding.

C. Termination. Stranded conductors for branch circuit wiring to snap switches and receptacles shall terminate at the wiring device with an insulated tin-plated copper spade compression terminal. Select a spade terminal compatible with the wiring devices supplied so that device screw terminals can be torqued to the wiring device manufacturer’s recommendations. Refer to Section 26 0519, Insulated Conductors.

D. Where more than one device occurs in one outlet box, such that the voltage between adjacent devices would exceed 300 volts, provide a barrier for isolation to comply with the requirements of NEC Article 404.8(B).

E. Location. The approximate location of switches, power outlets, floor boxes, etc., is indicated on the Drawings. These Drawings, however, may not give complete and accurate information in regard to locations of such items. Determine exact locations by reference to the general building Drawings and by actual measurements during construction of the building before rough in, subject to the approval of the Constructor Inspector and the Owner’s Representative.

F. Coordination.
1. Coordinate location, mounting height, and orientation of wiring devices with adjacent outlets for other systems such as HVAC control, voice/data, security, fire alarm, etc.
2. Communications Outlets. Where 4-plex receptacles (i.e., double duplex) are indicated or shown on the Drawings in the vicinity of communications outlets for voice, data, and telephone systems provide standard 4-inch by 4-inch recessed wall box flush with finished wall for communications outlet. Space 4-plex receptacle and communications outlet 6 inches horizontally between outside edges of adjacent boxes.
3. Casework and Millwork. Coordinate devices installed in casework and millwork with the location, finish, and mounting arrangement of the casework and millwork. Review applicable shop drawings and coordinate the installation with applicable Division.
4. Refer to Section 26 0537, Boxes, for additional requirements.

G. Wiring. Devices must be completely wired and installed. Provide hot, neutral, ground, and other connections of appropriate voltage as required for proper device and luminaire function. Luminaires and lighting controls must be operating properly at final completion.

3.5 RECEPTACLES

A. Location.
1. Install convenience outlets in a suitable steel outlet box centered at the height of 18 inches above floor, 8 inches above counters or above the backsplash level, or as indicated on the Drawings. Do not install receptacles partially in the backsplash and partially in the wall. Coordinate location with equipment and architectural Drawings.
2. Position the center of communications outlets (telephone, data, computer and TV) 18 inches above floor or 8 inches above countertops, unless otherwise noted or indicated. Do not install communications outlets partially in the backsplash and partially in the wall. Coordinate with communications (Voice/Data) supplier, architectural Drawings, shop drawings, and millwork.
3. Install specific-use receptacles at heights shown on Drawings.
4. Mount receptacles generally where indicated on Drawings. The Owner’s Representative reserves the right to make reasonable changes in receptacle locations without change in the contract sum.
B. Position.
   1. Install receptacles vertically with ground pole on bottom. Install receptacles horizontally, where field condition does not allow vertical installation, with ground pole on left.
   2. Where receptacles are located adjacent to wall switches or communication outlets, group devices and mount vertically, or as indicated on Drawings.

C. Type and Grade.
   1. Provide industrial-grade receptacles unless otherwise noted or specified.
   2. Provide locking-type receptacles (i.e., Twist-Lock) in corridors or other special type receptacles where indicated on Drawings.

D. Ground Fault Circuit Interrupter (GFCI). Provide GFCI-type receptacle for receptacles within 6-feet of a water source such as sinks. Connect branch circuit wiring to line-side terminals of GFCI receptacle. Feed through to non-GFCI receptacles is not permitted.

E. Furniture:
   1. Locate boxes serving electrified furniture as indicated on plans.
   2. Refer to Part 3 of Section 26 0537, Boxes.

3.6 WALL SWITCHES

A. Location.
   1. Set wall switches in a suitable outlet box centered at the height of 48 inches from the floor, except as otherwise shown.
   2. Where shown near doors, install switches and dimmers not less than 2 inches and not more than 12 inches from door trim.
   3. Verify door swings before rough in and locate switch on the strike side of the door as finally hung. Where glass wall or glass partition is indicated or provided at strike side of door, install switch on adjacent wall and clear of door swing.
   4. Where wainscot or backsplash occurs at the 48 inches level, install device in the wall above the wainscot or backsplash or as near the 48 inch level as possible to provide the most pleasing appearance. In no case shall the switch be installed partially in the wainscot or backsplash and partially in the wall.

B. Position. Install wall switches in a uniform position so the same direction of operation will open and close the circuits throughout the job, generally up or to the left for the ON position.

3.7 DEVICE PLATES

A. Type. Provide device plates for each outlet of the type required for service and device involved. Plates shall be provided for telecom and A/V per those documents

B. Ganged Devices. Mount ganged devices under a single, one-piece device plate.

C. Workmanship. Install devices and device plates level, plumb, and parallel to adjacent surfaces or trim. Devices shall be flush with the finished trim cover plates. Device plates shall be tight to surfaces over which they are installed.

D. Patching. Where cover plates do not completely conceal the rough openings for the devices, it shall be the responsibility of the Contractor to patch, paint, etc. around the opening to the satisfaction of the Owner’s Representative.
E. Engraving. Engrave plates with 1/8-inch-high black letters, if designated for engraving.

F. Labels. Where switches controlling devices that are out of sight, or where three or more switches are gang mounted, provide plates with labels to identify items being controlled, or areas being lighted. Refer to Section 26 0553 for Electrical Identification requirements.

END OF SECTION
SECTION 26 2813
FUSES – 600 VOLT AND BELOW

PART 1 - GENERAL

1.1 SUMMARY
A. This Section specifies the furnishing and installation of low voltage fuses rated 600 volts and below, 6000 amperes and below.

1.2 REFERENCE STANDARDS
A. ANSI/NEMA FU 1 - Low Voltage Cartridge Fuses.
B. ANSI/UL 248 - Fuses.

1.3 RELATED WORK
A. Section 26 0000, Electrical General Provisions.
B. Section 26 0573, Overcurrent, Protective Device Coordination Study.

1.4 SUBMITTALS
A. Provide product data on fuses.
B. Refer to Section 26 0573 for submittal requirements in conjunction with short circuit and overcurrent protective device coordination study.

PART 2 - PRODUCTS

2.1 VOLTAGE
A. Provide fuses with a voltage rating suitable for the nominal voltage of the system in which they are to be applied.

2.2 TYPES
A. Time Delay Fuses. Unless otherwise indicated, provide UL Class RK-1 time delay, current limiting fuses having 200,000 rms symmetrical amperes interrupting rating. Use on 600-ampere or smaller circuits where indicated.
B. Non-Time Delay Fuses. Fuses indicated by "K 1" on the drawings are UL Class RK 1 non-time delay having 200,000 rms symmetrical amperes interrupting rating. Use on 600-ampere or
smaller circuits supplying branch circuit panelboards, resistance heating, and where otherwise indicated.

C. Class L Fuses. Fuses rated 601 to 6000 amperes are UL Class L with 200,000 rms symmetrical amperes interrupting rating.

2.3 MANUFACTURER

A. Bussman.

B. Ferraz Shawmut.

C. Littelfuse.

D. Low voltage fuses must be products of a single manufacturer.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. Deliver fuses individually wrapped, in factory-fabricated containers.

B. Store fuses in a clean and dry space and protected from weather, moisture, corrosion and damage.

C. Handle products carefully to avoid damage to material components and finish. Damaged fuses shall be rejected and not be installed on project.

D. Refer to paragraph 3.2 of Section 26 0000, Electrical General Provisions.

3.2 COORDINATION

A. Coordinate fuse selection with the short circuit and overcurrent protective device coordination study.

B. Refer to Section 26 0573 for additional requirements.

3.3 INSTALLATION

A. Instructions. Follow the manufacturer's installation instructions.

B. Fuse Clips. Check fasteners on fuse clips for tightness when installing fuses.

C. Labels. Install fuses so label is in an upright, readable position. Fuses without labels are not acceptable.
3.4 SPARE FUSES

A. As spares, provide the greater amount of either three fuses or 10 percent of each size and type installed. Deliver the spare fuses to the Owner at the time of final acceptance of the project.

END OF SECTION
SECTION 26 2816
ENCLOSED SAFETY SWITCHES

PART 1 - GENERAL

1.1 SUMMARY
A. This Section specifies the furnishing and installation of enclosed safety switches. All switches shall be fused.

1.2 REFERENCE STANDARDS
A. ANSI/UL 98 - Enclosed and Dead-Front Switches.
B. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches.
C. NFPA 70 - National Electrical Code (NEC).
D. NFPA 70E - Standard for Electrical Safety in the Workplace.

1.3 RELATED WORK
A. Section 26 0000, Electrical General Provisions.
B. Section 26 2813, Fuses - 600 Volt and Below.
C. Section 26 0573, Overcurrent Protective Device Coordination Study.

1.4 SUBMITTALS
A. Provide product data on each type and rating of switch.
   1. Ratings including voltage, and horsepower or continuous current.
   2. Dimensioned outline drawings.
   3. Conduit entry/exit locations.
   4. Cable terminal sizes.
   5. Wiring diagrams.
B. Provide arc-flash calculations and associated incident energy levels. Refer to Section 26 0573, Overcurrent Protective Device Coordination Study.
PART 2 - PRODUCTS

2.1 CHARACTERISTICS

A. Voltage. Provide switches with a voltage rating of 250 volts d-c, 240 volts or 600 volts a-c, as required for the installed system voltage.

B. Type. Provide switches conforming to NEMA KS 1 standard for Type HD (heavy duty).

C. Contacts. Provide switches with quick-make, quick-break contacts.

D. Poles. Unless otherwise shown, provide 3-pole, visible blade switches.

2.2 CONSTRUCTION

A. Enclosure. Provide NEMA 1 enclosures for switches in indoor dry locations. Provide NEMA 4X enclosures for switches located outside the building conditioned envelope and in corrosive environments, unless otherwise shown.

B. Operating Handle. Provide a handle suitable for padlocking in the OFF position with as many as three padlocks of 5/16-inch diameter shank. Use a defeatable, front accessible, coin-proof door interlock to prevent opening the door when the switch is in the ON position and to prevent turning the switch ON when the door is open.

C. Terminal Shield. Provide incoming line terminals with an insulated shield so that no live parts are exposed when the door is open.

D. Neutral. Provide each switch with an isolated, fully rated neutral block. Make provisions for bonding the block to the enclosure.

E. Ground. Provide each switch with a ground lug.

F. Fuse Holders. Provide switches with rejection-type fuse holders which are suitable for use with fuses specified under Section 26 2813, Fuses - 600 Volt and Below. All switches shall be fused.

G. Nameplates. Provide metal nameplates, front cover mounted, which indicate the switch type, catalog number and horsepower rating (with both standard and time delay fuses).

2.3 LISTING


2.4 MANUFACTURERS

A. GE Company.

B. Square D Company.

C. Eaton/Cutler-Hammer.
PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. Deliver products individually wrapped, on pallets or in factory-fabricated fiberboard type containers.

B. Store products in a clean and dry space, elevated above grade, and protected from weather, sunlight, moisture, corrosion, dirt and damage.

C. Handle products carefully to avoid damage to material components, enclosure and finish. Damaged products shall be rejected and not be installed on project.

D. Refer to Paragraph 3.2 of Section 26 0000, Electrical General Provisions.

3.2 INSTALLATION

A. Install safety or disconnect switches where indicated, in accordance with the manufacturer's written instructions, and the applicable requirements of NEC. Install safety and disconnect switches in accordance with the directions of the Owner’s Representative.

B. In general, mount switches and disconnects so that operating handle is approximately 60 inches above finished floor. Where grouped, align tops of switches.

C. For equipment with motors larger than 1/8 hp, provide disconnect switches within sight of the motor.

D. Mount motor and circuit disconnect enclosures, independent of equipment served, on columns or freestanding on a bolted unistrut-type or galvanized welded angle iron framework anchored to floor. Refer to Section 26 0529, Metal Framing and Supports.

E. Switch interiors shall be maintained clean until final acceptance by Owner. Switch exteriors shall be maintained free of mud, spray-on insulation, paint spray and other substances not placed on the exterior surface by the switch manufacturer.

3.3 FUSIBLE DISCONNECT SWITCHES

A. Provide fusible disconnect switches only. Coordinate with Divisions 14, 21, 22, 23, and equipment supplier for warranty and listing requirements of equipment approved by submittal.

B. Coordinate fuse selection with the overcurrent protective device coordination study. Refer to Sections 26 0573.

C. Install fuses in fusible disconnect switches. Provide permanent marking inside and outside the switch enclosure for fuse type and size.

END OF SECTION
SECTION 26 4313
SURGE PROTECTION DEVICE SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including “Uniform General Conditions and Supplementary General Conditions for the State of Texas Building Construction Contracts”, and Division 01 sections apply to the work of this Section.

1.2 SUMMARY

A. This Section specifies the furnishing and installing of type 1 Surge Protective Devices (SPDs), used as a component of a facility-wide suppression system implemented in conjunction with type 2 SPDs in branch circuit panelboards. The specified unit installed in the facility-wide suppression system shall provide effective high-energy transient voltage suppression, surge current diversion, and line control in high-exposure ANSI/IEEE C62.41-1991 environments on the load side of the facility main overcurrent protective device (OCPD). Units installed in the facility-wide suppression system are indicated by the designation SPD (Surge Protection Device) on Drawings.

1.3 STANDARDS

A. The specified units installed in the facility-wide suppression system shall be designed, manufactured, tested, and installed in compliance with the following standards:

B. American National Standards Institute and Institute of Electrical and Electronic Engineers:
   1. ANSI/IEEE C62.41.1, Recommended Practice for Surge Voltages in Low-Voltage AC power Circuits.


D. Federal Information Processing Standards Publication 94 (FIPS PUB 94).

E. Military Standards (MIL-STD 220A).


G. National Fire Protection Association (NFPA):
   1. NFPA 75, Protection of Information Technology Equipment.
   2. NFPA 70, National Electrical Code (NEC), Article 285.

H. Underwriters Laboratories (UL):
   1. UL 248, Low Voltage Fuses.
2. UL 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker
   Enclosures.

1.4 RELATED WORK

A. Section 26 2416, Panelboards – Distribution and Branch Circuit.
B. Section 26 4313, Surge Protection Device.
C. Section 26 0573, Overcurrent Protective Device Coordination Study.

1.5 SUBMITTALS

A. Submittals after fabrication:
   1. Instruction manual describing each unit provided. Manual shall conform to the
      requirements of Operations and Maintenance (O&M) manuals per Section 26 0000,
      Electrical General Provisions.
   2. Spare Parts: A list of customer-replaceable spare parts for each unit installed in the
      facility-wide suppression system shall be included in the unit installation, operation and
      maintenance instructions. Spare parts shall be quickly and easily field-replaceable.
   3. Field Testing: Submit to the Owner’s Representative and to the Architect/Engineer
      documentation of field testing performed in accordance with Part 3 of this Section,
      demonstrating compliance with the requirements of this Section. Where not specified
      otherwise, provide three copies to the Architect/Engineer and one copy to the Owner’s
      Representative.

B. Panelboards: Refer to Section 26 2416, Panelboards – Distribution and Branch Circuit, for
   submittal requirements for distribution and branch circuit panelboards as indicated in
   Construction Drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Square D
B. GE
C. Current Technology
D. Eaton.

2.2 SPD RATINGS

A. Refer to drawings for operating voltage, configuration.
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 not more than 10% deterioration or degradation of the UL1449 3rd Edition Voltage Protection Rating (VPR) due to repeated surges. Unit shall have a monitoring option available to be able to test and determine the percentage of protection available at all times.

D. Protection Modes of UL1449 3rd Edition Voltage Protection Rating (VPR) (6kV, 3kA) for grounded WYE/delta and with voltages of (480Y/277). 3-Phase, 4 wire circuits.

E. Provide equipment with an integral disconnect with the following ratings:

<table>
<thead>
<tr>
<th>System Voltage</th>
<th>Mode</th>
<th>MCOV</th>
<th>B3 Wave</th>
<th>C3 Comb. Wave</th>
<th>UL 1449 3rd Edition VPR Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>120/208</td>
<td>L-G</td>
<td>150</td>
<td>400</td>
<td>650</td>
<td>700</td>
</tr>
<tr>
<td></td>
<td>N-G</td>
<td>0</td>
<td>350</td>
<td>500</td>
<td>900</td>
</tr>
<tr>
<td></td>
<td>L-L</td>
<td>300</td>
<td>400</td>
<td>950</td>
<td>900</td>
</tr>
<tr>
<td>277/480</td>
<td>L-N</td>
<td>320</td>
<td>550</td>
<td>1125</td>
<td>900</td>
</tr>
<tr>
<td></td>
<td>L-G</td>
<td>320</td>
<td>850</td>
<td>1075</td>
<td>1200</td>
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<tr>
<td></td>
<td>N-G</td>
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<tr>
<td></td>
<td>L-L</td>
<td>550</td>
<td>650</td>
<td>1950</td>
<td>1800</td>
</tr>
</tbody>
</table>

F. If SPDs are submitted with integral disconnect ratings must be adjusted to comply with UL 1449 3rd Edition.

G. Provide SPDs with nominal discharge current rating of 20kA/mode.

H. Surge Rating - Provide SPDs with a minimum surge rating of 200kA per mode.

I. Electrical Noise Filter- each unit shall include a high performance EMI/RFI noise rejection filter. Noise attenuation for electric noise shall be as follows using the MIL-STD-220A insertion loss test method.
   1. 100 kHz at 41 db.
   2. All other frequencies should be 31 db or better.

J. Each Unit shall provide the following features:
   1. Phase Indicator lights, Form C dry contacts, counter and audible alarm.
   2. Field testable while installed.

K. Suppression/Filter System: UL 1283 minimum insertion loss obtained utilizing MIL-STD-E220A 50 ohm insertion loss methodology. (100 kHz - 1 MHz): 34 dB (50:1).

2.3 FUSING

A. Fuse Components Identification and Surge Rating: The surge rating (8 x 20 µsec) of the fuse shall be greater than the combined surge current rating of downstream connected suppression elements.
B. Suppression Components Identification and Surge Rating: The suppression elements connected in series with fuse elements shall provide the suppression elements published 8 x 20 µsec surge current rating. The rating of the suppression elements shall be less that the rating of upstream fusing elements.

C. Surge Performance: Fusing shall be required to meet the single pulse surge current testing requirements described above.

D. Isolation: The unit shall have each MOV fused and designed to operate only in the event of a MOV failure within the unit.

E. UL Rating: Fusing shall be 200kAIC UL248 Recognized.

2.4 BUSSING

A. Transient Conduction Path: Full magnitude transient currents shall be conducted on low-impedance solid copper bussing. Printed circuit board traces shall not be used to conduct or shunt transient voltage surge currents.

2.5 MONITORING

A. Visual: Monitoring shall include one set of status monitoring lights that will provide visual indication of voltage present to the SPD for each phase of protection. The lights shall also indicate when suppressor protection has degraded to a value of less than 50%.

B. Alarm: The unit shall include an audible alarm with battery backup, a current-sensing surge counter, and two sets of Form C contacts for remote monitoring.

2.6 ENCLOSURE

A. Provide an SPD assembly that is UL listed.
   1. If required to maintain a UL listing of both the SPD and the associated distribution equipment, then provide the SPD in a separate NEMA Type 12 enclosure sized per the SPD manufacturer's recommendations. Install the SPD per manufacturer recommendations. Install the externally mounted SPD so that the conductor length is a maximum of 5'-0".
   2. Where UL listed for installation in the equipment, the arrangement of the SPD within the enclosure shall match and maintain the full wiring gutter fill capacity of the associated electrical equipment.

B. Finish: Exterior and interior steel surfaces shall be cleaned and finished with electrostatically applied “powder coat” thermoset enamel baked over a rust-inhibiting phosphatized coating. Exterior finish color shall be manufacturer's standard gray, ANSI 49 or ANSI 61, to match finish of associated panelboard.

2.7 LISTING

A. Units shall be UL 1449, Third Edition, listed and labeled as a Type 1 Surge Protection Device.
PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. Deliver surge protection devices, components and accessories individually wrapped, on pallets or in factory-fabricated fiberboard type containers, and protected from weather and damage.

B. Store surge protection devices, components and accessories in a clean and dry space, elevated above grade, and protected from weather, sunlight, moisture, dirt, and corrosion.

C. Surge protection devices, components, and accessories shall not be used as work tables, scaffolds, or ladders.

D. Handle surge protection devices, components, and accessories carefully to avoid damage to material components, enclosure and finish. Use only lifting eyes and brackets provided for that purpose. Damaged products shall be rejected and not be installed on project.

E. Refer to Section 26 0000, Electrical General Provisions.

3.2 INSTALLATION

A. General: Install surge protection device (SPD) internal to the electrical distribution equipment in accordance with manufacturer's wiring diagrams and written instructions and the applicable requirements of the NEC, NEMA, ANSI, local codes, and Owner requirements.

B. Install the SPD enclosure, or enlarge enclosure to house SPD as required, to the top or bottom of the panelboard at end opposite from the main circuit breaker or main lugs. Extend phase conductors from SPD to disconnecting means in the electrical equipment, as indicated on Drawings. Extend neutral and ground conductors from SPD to lugs at the neutral and ground busses, in accordance with manufacturer instructions. Connection leads shall not exceed 18 inches from the SPD to the circuit breakers:
   1. Where not otherwise indicated or specified, terminate SPD phase conductors to three single-pole circuit breakers in the panelboard connected by a handle tie.
   2. Where manufacturer instructions and UL-listing require a 3-pole circuit breaker as disconnecting means and overcurrent protection for the surge protection device, provide a 3-pole circuit breaker as the disconnecting means between the SPD and main bus.
   3. Provide overcurrent device for SPD connection to panelboard main bus, sized in accordance with manufacturer recommendations. Refer to Section 26 2416, Panelboards – Distribution and Branch Circuit.

C. Wire Size: Manufacturer’s recommended wire size for unit supplied. Where wire size is not indicated by manufacturer, provide conductors of same size as grounding conductor connected to the ground bus of the panelboard, #2 AWG minimum per phase, neutral, and ground. Use stranded copper conductor with THWN insulation, unless otherwise noted.

D. Equipment interiors shall be maintained clean until final Owner acceptance. Equipment exteriors shall be maintained free of mud, spray-on insulation, paint spray and other substances not placed on the exterior surface by the equipment manufacturer.

E. Inspection: Thoroughly inspect surge protection device and panelboard for items such as loose connections and presence of foreign materials and remedy prior to energizing the panelboard. Bolted connections shall be torqued to the manufacturer’s recommendations.
3.3 SYSTEM TESTING

A. Upon completion of installation, provide the start-up and testing services of a factory-authorized and factory-trained local service representative. The tests shall include:
   1. Off-Line testing: Impulse injection to verify the system tolerances as well as verification of proper facility neutral-to-ground bond. Compare field test results to factory benchmark test parameters supplied with each individual unit.
   2. On-Line testing: Verification that suppression and filtering paths are operating with 100% protection as well as verification of proper facility neutral-to-ground bond by measuring neutral-to-ground current and voltage and by visual inspection.
   3. Voltage measurements from Line-to-Ground (L-G), Line-to-Neutral (L-N), Line-to-Line (L-L), and Neutral-to-Ground (N-G), taken at the time of the testing procedure.

3.4 DOCUMENTATION AND REPORTING

A. Record results of field testing and compare to factory benchmark test parameters supplied with each individual surge protection device. Indicate that the integrity of neutral-to-grounds bonds was verified through testing and visual inspection, and that grounding bonds were observed to be in place.

B. Submit to the Owner’s Representative and to the Architect/Engineer copies of the startup test results and the factory benchmark testing results for confirmation of proper suppression filter system function, as required by paragraph 1.5A.3, this Section. Provide number of copies as required by Division 01 and Section 26 0000, Electrical General Provisions; and three copies where not otherwise specified.

3.5 SYSTEM WARRANTY

A. The SPD system shall be warranted against defective materials and workmanship for a period of ten years.

B. Warranties shall conform to the requirements of Division 01 and Section 26 0000, Electrical General Provisions.

END OF SECTION
SECTION 26 5100

INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies the furnishing and installation of luminaires complete with lamps, ballasts, and other accessories. Provide poles for exterior luminaires requiring such.

1.2 REFERENCE STANDARDS

B. NFPA 70 - National Electrical Code (NEC).
D. UL 924 - Emergency Lighting and Power Equipment.

1.3 RELATED WORK

A. Section 26 0000, Electrical General Provisions.
B. Section 26 0533, Raceways.

1.4 SUBMITTALS

A. Submit product data on each luminaire, emergency lighting unit, exit sign, and pole, with separate sheet for each luminaire, assembled by luminaire "type" in alphabetical order, with the proposed luminaire, ballast or Driver, lamps, and accessories clearly labeled. Submit at one time in booklet form.
   1. Include with submittal data dimensioned drawings and performance data including coefficients of utilization, candela distribution, spacing to mounting height ratio, efficiency, efficacy, and visual comfort probability.
B. LED: Provide documentation for performance of LED luminaires including LM 79, LM 80 reports and L70, L80 or L85 test results. Provide documentation for listed tolerances for variation in temperature color, or “binning”. Binning documentation shall include MacAdam steps diagram with range of binning clearly indicated. Provide testing data that clearly indicates listed environmental conditions for installation of luminaire including ambient temperature.
   1. LED luminaires with remote drivers shall clearly indicate required wattage and voltage tolerance of driver and maximum range for which driver can be installed remote to LED luminaire.
2. Provide power requirements for complete LED fixture package clearly indicating the lumen package and power consumption of the entire fixture package.
   a. Data indicating only lumen package and power requirements for individual LED modules incorporated into the complete fixture package is not acceptable.

C. Samples.
   1. When requested in writing by the Owner’s Representative or the Architect/Engineer, furnish samples of luminaire types.
   2. Deliver samples for luminaire types as requested, at a time and place designated by the requestor (Owner’s Representative or the Architect/Engineer).
   3. Samples shall be complete product models as proposed for use on the project.
   4. Furnish samples to the Owner at no additional cost.
      a. Samples shall not be installed on the project without the written consent of the Owner’s Representative and the Architect/Engineer.
      b. Upon written concurrence from the Owner’s Representative, samples furnished for the project may be retained by the Contractor for delivery as “spares” following Owner’s acceptance of the completed project.

PART 2 - PRODUCTS

2.1 LUMINAIRES

A. Lens. Lenses for luminaires shall have a nominal thickness of 0.125 inch.

B. Disconnecting Means. Provide luminaires for indoor locations with factory-installed disconnecting means complying with NEC-410.73(G).

C. Frames.
   1. Frames shall be flush steel. Alternate materials are indicated in Luminaire Schedules on Drawings.

D. Manufacturer. Luminaires are specified by type and manufacturer in the Luminaire Schedule on the Drawings. Equivalent products of manufacturers listed below will be considered upon submission of product data in accordance with paragraph 1.7 of Section 26 0000 and with paragraph 1.4 of this Section.
   1. LED. Acuity/Lithonia, Columbia, Cooper, Finelite, Focal Point, Kenall, LiteControl, Peerless, Zumtobel, Kurt Versen, LSI, Vantage, Kenall, HE Williams.
   3. Exit Signs. Refer to paragraph 2.6 this Section.
   4. Emergency Lighting Units. Refer to paragraph 2.4, this Section.

2.2 LAMPS

A. General. Provide lamps for luminaires. Types are specified in the Luminaire Schedule on the Drawings.

B. Light Emitting Diodes (LED) or Solid State Lighting
   1. Provide luminaire package with temperature variance limited to three MacAdam steps as defined in ANSI C79.377.
   2. Provide luminaire that is factory tested as a complete package with a LM-79 and LM-80 report.
3. Provide luminaire with individual LED boards. Replacement of individual LED boards shall be capable to be performed in the field and shall not require replacement of the entire unit or fixture.

4. Provide fixture with minimum 5 year warranty covering complete luminaire package.

5. Provide LEDs with phosphorous coating, for creation of white LEDs, at the individual LEDs and not at the luminaire lens or housing.

6. Provide luminaire with quick disconnect for LED drivers and individual LED boards.

7. Provide LED fixtures compatible with 0-10V or DALI non-proprietary controls.

8. Provide LED luminaires with appropriately sized heat sink.

2.3 BALLASTS/DRIVERS

A. General. Provide drivers for luminaires as required and as scheduled.

B. Light Emitting Diode (LED) Drivers

1. UL Listed as a complete assembly with luminaire,
2. RoHS and FCC compliant.
3. Minimum 5 year warranty.
5. UL Class 2 power limited per UL1310.
6. UL dry and damp location listed.
7. Power factor greater than 0.90 and <20% THD.
8. Driver shall operate at specified input voltage with sustained variation of +/- 10% with no damage to the driver.
9. Integral surge protective device.
10. Driver shall tolerate sustained open circuit and short circuit output conditions without fail and auto-resetting without need for external fuses or trip devices.
11. Minimum operating temperature -20C.
12. Driver output regulated +/- 5% over published load range. Output shall be compatible with LED board in specified luminaire.
13. Output current controls local to the driver (trimpot or programmable).
14. If specified on the Drawings, the driver shall dim within the range specified on the fixture schedule with no flicker.
15. Driver shall have integral thermal foldback to reduce driver power above rated case temperature to protect the driver if temperatures reach unacceptable levels.

C. Listings.

1. LED - UL1310 - Class 2 power supplies

D. Fuses. Provide in-line fuses in base of the pole for pole-mounted luminaires.

2.4 EMERGENCY BATTERY PACK/BALLAST

A. Where indicated on luminaire schedule or plans, provide luminaires with emergency ballasts. Emergency ballasts shall automatically provide for a minimum of 90 minutes of illumination in the event of loss of normal power to the building. Where larger capacity is indicated on plans or schedules, provide unit with larger capacity.

B. Emergency battery packs/ballasts shall comply with the following requirements:

1. Exceed the NEC, LSC, and UL 90-minute requirements, and carry the UL label.
2. Contain high-temperatures nickel cadmium batteries that are maintenance free and fully recharge within 24 hours.
3. Are backed by full (non pro-rata) warranties, 5-year for linear fluorescent lamps and 2-year for compact fluorescent lamps.

4. Capable of operating one or two lamps, with minimum lumen output as indicated on the Drawings.

C. Manufacturer. Bodine, and the scheduled luminaire manufacturers.

2.5 EMERGENCY LIGHTING UNITS

A. See plans.

2.6 EXIT SIGNS

A. Manufacturer. Refer to the scheduled luminaire manufacturers.

B. See plans.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

A. Deliver luminaires, exit signs, emergency lighting units, and accessories individually wrapped in factory-fabricated fiberboard type containers.

B. Handle luminaires, exit signs, emergency lighting units, and accessories carefully to prevent breakage, denting and scoring the luminaire finish. Do not install damaged units.

C. Store luminaires, exit signs, emergency lighting units, and accessories in a clean, dry space, elevated above grade, and protected from the weather and sunlight.

D. Refer to paragraph 3.2 of Section 26 0000, Electrical General Provisions.

3.2 COORDINATION

A. Prior to ordering luminaires, check the type of ceilings to be installed in each room and verify that the luminaires are proper and compatible for the type of ceiling as specified and as indicated on the architectural Drawings. Provide a frame compatible with the type of ceiling in which the luminaire is installed. Refer to the Drawings and the Architectural Room Finish Schedule for the specified ceiling type. Advise the Owner’s Representative of discrepancies before placing the luminaire order.

B. Check the building electrical system requirements and architectural finishes, and regardless of the catalog number prefixes and suffixes shown, furnish luminaires with the proper trim, frames, plaster rings, supports, hangers, stems, mounting brackets, ballasts, voltage rating, and other miscellaneous appurtenances to properly coordinate with said conditions. Verify with Owner’s Representative prior to ordering.

C. If a luminaire type designation is omitted, furnish luminaire of the same type as shown for rooms of similar usage. Verify with Owner’s Representative before purchase and installation.
D. Examine the areas and conditions which luminaires are to be installed and notify the Owner’s Representative and the Architect/Engineer in writing of conditions detrimental to the proper and timely completion of the work. Include written plan for correction of deficiencies and conditions noted. Do not proceed with the work until unsatisfactory conditions have been corrected.

E. Verify that the occupancy sensors are compatible with the specified ceiling systems as indicated on the Drawings. Advise the Architect/Engineer of discrepancies before placing the device order.

F. Verify that the fluorescent dimmers are compatible with the specified dimming ballasts, as indicated on Drawings.

G. Coordinate luminaire installation with lighting controls.

3.3 INSTALLATION

A. Install luminaires in accordance with the manufacturer’s written instructions, Owner’s requirements, the applicable requirements of NEC and local and national Codes, Standards, and regulations.

B. Install luminaires at locations as shown on the Drawings, install aligned, aimed, and leveled. Install luminaires in accordance with manufacturer's installation instructions complete with mounting accessories, trim and support materials.

C. Support.
   1. Provide hangers and support members for luminaires as required for proper installation. Provide appurtenances which include stud supports, stems, mounting brackets, frames and plaster rings.
   2. Support luminaires from the building structure or from furring channels. Furring channels must be a minimum size of 1-1/2 inches. Luminaires in suspended ceilings shall be supported in accordance with NEC 410.16.
   3. Fasten luminaires securely to structural support members of the building. Support grid-type lay-in luminaires from the structure above at each corner of luminaire. 1/4 inch expansion slip ring anchorage with eye and ceiling-type support wire is permitted. Two wires may be supported by one anchorage if required by construction conditions, such as obstructions by other system. Solid pendant luminaires shall be plumb.
   4. Provide support for 1/2 inch pre-manufactured flexible metal conduit (FMC) whips from structure above. Whips shall not touch ceiling system as finally installed. Whips shall be kept 12 inches clear of ceiling except where required for termination at luminaires. Use of “fixture support wire installation” with caddy clip is permitted.
   5. Flexible metal conduit from junction box to luminaire shall not touch the ceiling as finally installed.

D. Coordinate with other crafts to avoid conflicts between luminaires, supports, fittings and mechanical equipment.

E. Surface Mounted Luminaires.
   1. Mount with support rails attached to ceiling suspension support system, provided ceiling system has been certified to be suitable to support weight of luminaires.
   2. Where ceiling system has not been certified to support weight of luminaires, luminaires shall be supported at four points near each corner of luminaires.
   3. Provide a minimum 5/8” air space between the luminaires and the ceiling.
F. Recessed Luminaires.
   1. Handle specular/semi-specular louvers and down light cones using only new clean white cotton or silk gloves. Do not touch louvers or cones with bare hands. Leave luminaires clean and free of visible dust, debris, or fingerprints with lamps operational at time of acceptance of work.
   2. Recessed fluorescent luminaires in lay-in grid shall be supported independently from building structure above ceiling with galvanized steel wire at not less than 4 points near corners of luminaires. Size of wire shall be capable of supporting weight of luminaires. This requirement is separate and apart from hanger wire requirements of the ceiling grid.
   3. Recessed luminaire trims shall fit snugly to the mounting surface and shall not exhibit light leaks or gaps. Provide feed-through junction boxes or provide separate junction boxes. Components shall be accessible through the ceiling opening.

G. Protect installed luminaires from damage during the remainder of the construction period.

H. Luminaires must be completely wired and lamps installed. Luminaires must be operating properly at final completion.

I. Adjustment.
   1. Adjust luminaires to illuminate intended areas as directed.
   2. Adjust exterior luminaires during hours of darkness. Where acceptable to the Owner’s Representative, exterior luminaires may be adjusted during daylight hours; verification of adjustments shall be conducted during hours of darkness.

J. Upon completion of installation of interior luminaires, and after circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

K. Immediately before final observation, clean luminaires, inside and out, including plastics and glassware, and adjust trim to properly fit adjacent surface, replace broken or damaged parts and lamp, and test luminaires for electrical as well as mechanical operation.

L. Lamp Disposal. The procedure for disposal of lamps that contain mercury shall follow the guideline set by EPA (definitions in Title 40 Code of Federal Regulations 261 Subpart C, January 2000).

3.4 TESTING

A. The Contractor shall demonstrate to the Owner the proper operation of luminaires, systems and equipment specified in this Section and related Sections. The Contractor shall adjust, repair or replace as necessary components that do not perform as specified, until able to demonstrate proper operation of equipment in normal, automatic, manual, emergency, power-loss, and power-restored modes of operation, as applicable.

3.5 SYSTEM WARRANTY

A. The system shall be warranted against defective materials and workmanship for a period of five years including, but not limited to, metal corrosion, color retention, lamps, ballasts, dimming drivers, etc.

B. Warranty period shall begin from the date of substantial completion.
3.6 SPARE PARTS
   A. Provide 10% spare LED drivers for each type and rating.
   B. Provide 10% spare lenses for each type of interior lighting.

3.7 TRAINING
   A. Provide 4 hours training at Substantial Completion of the project for the lighting control system.

END OF SECTION
SECTION 27 0000
COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes general design requirements, administration topics, and installation for communications systems.

1.2 SYSTEM DESCRIPTION

A. The objective of this project is to provide a complete communications cabling infrastructure system installation including, but not limited to: fiber backbone, riser system, horizontal data and voice cabling with attendant terminations, mounting equipment, cable pathway and management systems, testing and other items/materials, as specified in drawings, these specifications, and contract documents.

B. Related Sections

1. Section 260000 Electrical (including related sub-sections)
2. Section 270526 Grounding and Bonding for Communications Systems
3. Section 270528 Pathways for Communications
4. Section 271100 Communications Equipment Room Fittings
5. Section 271300 Communications Backbone Cabling
6. Section 271500 Communications Horizontal Cabling
7. Section 274100 Audio-Visual Systems
8. Section 280000 Electronic Security (including related sub-sections)

1.3 SCOPE OF WORK

A. This section establishes an infrastructure to be used as signal pathways for communications systems, but is not limited to the following:

1. Comply with all Project Contract documents and the following requirements for a complete project installation.
2. Provide a structured cabling system as described hereafter that includes, but is not limited to, supplying, installing and testing of: backbone cabling, riser cabling; data and voice horizontal cabling, cable connectors, communications outlets and terminations, and equipment racks/cabinets for networking hardware and patch panels.
3. Furnish all labor, materials, tools, equipment and services for the installation described herein.
4. Follow industry standard installation procedures for communications cable to assure that the mechanical and electrical transmission characteristics of this cable plant and equipment are maintained.
B. Work of this section covers complete installation of permanent links for a data and voice communications networks utilizing copper and fiber transmission media that includes, but is not limited to the following:

1. Provide, install, terminate, test, and document all fiber and copper backbone cables, riser cables, and horizontal cables.
2. Provide and install all termination devices such as, but not limited to, modular patch panels, termination blocks, information outlets (jacks and plates), phone jacks, fiber distribution panels, bulkheads, connectors, and fiber fan out kits. Document all termination devices with proper labeling.
3. Provide in quantities specified, interconnect components such as, but not limited to, fiber patch cables, copper patch cords, and station cables.
4. Provide and install specified Telecommunication Room equipment such as, but not limited to, racks, cabinets, horizontal and vertical cable support devices, cable trays and cable runway, and required mounting brackets/hardware.
5. Provide and install UL-approved firestopping systems in all communication pass-through locations of rated ceiling, wall or floor penetrations involving, conduits, cable, and cable trays in coordination with General Contractor.
6. Provide and install grounding and bonding connection to the bus (PBB/SBB) provided by Division 26.
7. Provide and install all appropriate consumable items required to complete the installation.
8. Coordination with other trades.
9. Provide complete documentation and demonstration of work.
10. Provide indexed and organized complete Test Results of all copper and fiber cable and their components in native format.
11. Provide Submittals as outlined below.
12. Provide a Manufacturer’s Extended Product Warranty and System Assurance Warranty for this wiring system.
13. Conduct a final document handover meeting with client, consultant, and PM to review, discuss and educate the Owner on the final product, test results, and As-Built Drawings.

C. Changes to the Scope of Work

1. Owner changes to the scope of work shall be in writing.
2. Change orders shall be submitted to the Owner/Project Manager complete with price breakdown and description for approval before any work is done.
3. The Contractor shall respond to these changes with a complete material list, including pricing, labor, and taxes in writing to be presented to the Owner for approval.
4. The Contractor shall not proceed with additional scope of work without signed approval by the Owner. Owner will not pay for additional work performed by the Contractor without written/signed approval of these changes.
5. Contractor will attach a copy of the signed change order with billing information.

1.4 PRODUCTS AND WORK BY OTHERS (NIC)

A. The Owner may separately procure and/or provide certain equipment and component that will be installed during the course of project. Such items may not be indicated in the documents.

B. Contractor shall cooperate with the Owner and Owner’s suppliers when considering:

1. The provision and installation of phone systems, related system equipment/software, and employee station equipment/software.
2. The provision and installation of multi-port routers, switches, and other Layer 2 / Layer 3 networking components in communications rooms.
3. The provision and installation of Uninterruptable Power Source (UPS) devices in communications rooms.
4. Communications grounding busbars and grounding wires connecting to the main building electrode system.
5. Dedicated power panels, ground busbars, circuits, and utility outlets.
6. The installation and finishing of plywood backboards.
7. Building mechanical ductwork, cooling/heating system (HVAC), and environmental control sensors.
8. Communication pathway devices such as, but not limited to, cable tray and flex-tray in corridors, office spaces and open areas, outlet boxes and stub-ups, conduits, conduit sleeves, and penetrations in walls and floors.

1.5 SUBSTITUTION PROCEDURES

A. Substitution may be considered when a product becomes unavailable through no fault of the Contractor. An alternate product must be equal to or exceed specified requirements. The material substituted shall not void, alter or change manufacturers’ structured cabling system warranty.

B. Document substitution requests with complete data substantiating compliance of proposed substitution with Contract Documents. Include in each request for substitution:

1. Product identification, manufacturer’s name and address.
2. Product Data:
   a) Description, performance and test data, reference standards, finishes and colors.
   b) Samples: Finishes.
   c) Complete and accurate drawings indicating construction revisions required (if any) to accommodate substitutions.
   d) Data relating to changes required in construction schedule.
   e) Cost comparison between specified and proposed substitution.

C. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.

D. The Owner will be the final judge of acceptability, with review by DataCom Design Group and the distribution of the acceptance by the Architect.

E. No substitute shall be ordered, installed or utilized without the Architect’s prior written verification of acceptance from the Owner.

1.6 REFERENCES AND RELATED DOCUMENTS

A. Drawings and General provisions of the contract, including Uniform General Conditions, Supplementary General Conditions, Architectural plans and specifications, requirements of Division 1, Electrical, Mechanical, Plumbing, Audio-Visual, Security and Communications
specifications and plans, and the publications listed below apply to the Communications section, are incorporated into this specification by reference, and shall be considered a part of this section.

B. Reference to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean reference to the latest printed edition of each in effect at the date of contract.

C. The Contractor shall read all sections in their entirety and apply them as appropriate for work in this section.

D. Conflicts

1. Drawings and specifications are to be used in conjunction with one another and to supplement one another.
2. In general, the specifications determine the nature and quality of the materials and tests, and the drawings establish the quantities, details, and give characteristics of performance that should be adhered to during the installation of the communications system components.
3. If there is an apparent conflict between the drawings and specifications, or between specification sections, the items with the greater quantity and/or quality shall be estimated and installed.
4. Clarification with the Owner and/or DataCom Design Group about these items shall be made in writing prior to procurement and installation.

E. Codes and Standards

1. American National Standards Institute/Telecommunications Industry Association (ANSI/TIA)
   a) ANSI/TIA-568.0-E "Generic Telecommunications Cabling for Customer Premises"
   b) ANSI/TIA-568.1-E "Commercial Building Telecommunications Infrastructure Standard"
   c) ANSI/TIA-568.2-D "Balanced Twisted-Pair Telecommunication Cabling and Components Standard"
   d) ANSI/TIA-568.3-D "Optical Fiber Cabling Components Standard"
   e) ANSI/TIA-568.4-D "Broadband Coaxial Cabling and Components Standard"
   f) ANSI/TIA-569-E "Telecommunications Pathways and Spaces"
   g) ANSI/TIA-606-C "Administration Standard for Commercial Telecommunications Infrastructure"
   h) ANSI/TIA-607-D "Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications"
   i) ANSI/TIA-862-B "Building Automation Systems Cabling Standard"
   j) ANSI/TIA-1152-A; "Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling"
2. BICSI
   a) BICSI Telecommunications Distribution Methods Manual (TDMM)

3. National Electrical Code (NEC)

4. National Electrical Manufacturers Association (NEMA)
   a) NEMA RN1 Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
   b) NEMA TC2 Electrical Polyvinyl Chloride (PVC) Tubing and Conduit
   c) NEMA TC3 Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing
   d) NEMA VE 1 - Metal Cable Tray Systems
   e) NEMA VE 2 - Cable Tray Installation Guidelines

5. Local, county, state and federal regulations and codes in effect as of date of installation.

   a) It shall be indicated in the proposal the components that may be of foreign manufacture, if any, and the country of origin.

1,7 QUALITY ASSURANCE

A. Communications Contractor shall have a complete working knowledge of low voltage communications cabling applications such as, but not limited to data, voice and video network systems.

B. Communications Contractor shall have installed similar-sized systems in at least ten (10) other projects in the last five (5) years prior to this bid and be regularly engaged in the business of installation of the types of systems specified in this document.

C. Communications Contractor and individual installation crew members shall be experienced and qualified to perform the work specified herein at time of bid submission. All onsite supervision personnel that will be assigned to this project shall be listed in the Pre-Installation Submittal.

1. 80% shall have a minimum of three (3) years of experience in the installation of the types of systems, equipment, and cables specified in this document prior to this bid.
2. All installation team members must demonstrate knowledge and compliance with all applicable methods, standards, and codes.
3. All members of the installation team shall be certified by the Structured Cabling System Assurance Warranty provider as having completed the necessary training to complete their part of the installation and capable of an installation that falls under manufacturer’s guidelines necessary to obtain the Manufacturer’s System Assurance Warranty.
4. Any personnel substitutions shall be noted in writing to the Owner.

D. A BICSI RCDD shall supervise and approve all on-site work as a recognized member of the Contractor’s installation team.
E. Refer also to General Conditions.

1.8 CONTRACTOR REQUIREMENTS

A. In order to accomplish the conditions of this agreement, the Contractor shall perform the specific duties listed herein.

B. Contractor shall provide and pay for all labor, supervision, tools, equipment, test equipment, tests and services to provide and install a complete communications cabling infrastructure system. Pay all required sales, gross receipts, and other taxes.

C. Insurance

1. The Contractor shall procure, submit for review, and maintain for the duration of this agreement, insurance against claims for injuries to persons or damages to property which may arise from, or in connection with, the performance of work hereunder by the Contractor, his agents, representatives, employees or subcontractor. The Contractor shall pay the cost of such insurance.

2. The Owner, its directors, officers, representatives, agents and employees, respectively, shall have no responsibility to the Contractor with respect to any insurance in accordance with the provisions set forth herein.

D. Regulatory Requirements

1. Communications Contractor shall supply all city, county, and state telecommunication cabling permits required by Authority Having Jurisdiction (AHJ).

2. Communications Contractor shall be licensed and/or bonded as required for telecommunications/low voltage cabling systems.

E. Privacy and Confidentiality

1. The Contractor will respect and protect the privacy and confidentiality of Owner, its employees, processes, products, and intellectual property to extent necessary, consistent with the legal responsibilities of the Owner policies.

2. Contractors shall sign a non-disclosure agreement and abide by the requirements to keep confidential all information concerning bid documents and this project.

F. Use of Subcontractors

1. Successful bidder shall inform the Owner’s contact and General Contractor in writing about the intention to use Subcontractors and the scope of work for which they are being hired.

2. The Owner or Owner’s designated contact must approve the use of Subcontractors in writing prior to the Subcontractor’s hiring and start of any work.

G. The Contractor’s designated Project Manager will be recognized as the single point of contact. The Project manager shall oversee all work performed to ensure compliance with specifications as outlined in bid documents (which includes all specifications, references, and drawings) to ensure a quality installation and attend project meetings with the telecommunication consultant, the Owner and others.

H. Coordination
1. Coordinate installation work with other trades (examples include ceiling grid contractors, HVAC and sheet metal contractors, etc.) to resolve procedures and installation placement for cable trays and cable bundle pathways.

2. The goal of this coordination will be to establish priority pathways for critical data/voice network cable infrastructure, materials, associated hardware, as well as mitigate delays to the project and to allow service access for communications and HVAC components.

3. Exchange information and agree on details of equipment arrangements and installation interfaces.

4. Coordinate with electrical contractors and plan for the pathway routes used communications cabling to minimize cable lengths. Report any potential over distance cable runs for approval before pulling the cables.

5. Record agreements with other trades and distribute record to other participants, Owner and telecommunication consultant.

1.9 PRE-INSTALLATION MEETINGS

A. Communications Contractor shall attend and/or arrange a scheduled pre-installation conference prior to beginning any work of this section. This venue is to ask and clarify questions in writing with consultant and/or project manager/Owner representative.

B. Agenda

1. Safety
2. Work to be performed
3. Scheduling
4. Coordination
5. Other topics as necessary

C. Attendance

1. Communications project manager/supervisor shall attend meetings arranged by General Contractor, Owner’s representatives, and other parties affected by work of this document.
2. All individuals who will serve in an on-site supervisory capacity, including project managers, site supervisors, and lead installers, shall be required to attend the pre-installation conference. Individuals who do not attend the conference will not be permitted to supervise the installation and testing of communications cables on the project.

1.10 CONTRACT ADMINISTRATION

A. DataCom Design Group may perform site visits and provide job field reports upon inspection of Contractor’s installation, materials, supporting hardware, coordination with other trades and progress to schedule to the client.

B. Job Field Report outline:

1. General: The general installation progress in relation to scheduled work made by the Contractor up to that date.
2. Deficiencies and/or Items of Note: Documents observations of the cable installation that may require corrective action by the Contractor.

1.11 POST INSTALLATION MEETINGS
A. At the time of substantial completion the contractor shall call and arrange for a post installation meeting to present and review all submittal documents to include but not be limited to As-Built Drawings, Test reports, Warranty paperwork, etc.

B. Attendees shall include

1. Communications Contractor
2. Project Manager/Owner Representative
3. DataCom Design Group
4. General Contractor
5. Other trades that the GC deems appropriate.

C. At this meeting the Communications Contractor shall present and explain all documentation.

D. Any discrepancies or deviations noted by and agreed to by participants shall be remedied by the Communications Contractor and resubmitted within one (1) week of the meeting.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Coordination with delivery companies, drivers, site address, and contact person(s) will be the responsibility of the Contractor.

B. Communications Contractor requirements:

1. Be responsible for prompt material deliveries to meet contracted completion date.
2. Coordinate deliveries and submittals with the General Contractor to ensure a timely installation.
3. No equipment materials shall be delivered to the job site more than three weeks prior to the commencement of its installation.
4. Equipment shall be delivered in original packages with labels intact and identification clearly marked.
5. Equipment shall not be damaged in any way and shall comply with manufacturer’s operating specifications.
6. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust, or other contaminants.
7. Equipment damaged prior to system acceptance shall be replaced at no cost to the Owner.
8. Contractor shall be responsible for all handling and control of equipment. Contractor is liable for any material loss due to delivery and storage problems.

C. Owner/General Contractor shall provide the security requirements for Contractor to follow.

1.13 PROJECT/SITE CONDITIONS

A. For all environmental recommendations, refer to master Architectural section.

B. For all security recommendations, refer to related consultant sections.

C. Contractor shall provide daily a clean work environment that is free from trash/rubbish accumulated during and after cabling installation.
D. Contractor shall keep all liquids (drinks, sodas, etc.) away from finished spaces. If any liquid or other detriment (cuts, soils, stains, etc.) damages any finishes, Contractor shall provide professional services to clean or repair scratched/soiled finishes, at Contractor's expense.

E. Damage by Communications Contractor to the work of others will be remedied at the Contractor's expense in a timely manner.

1.14 WARRANTY

A. The Contractor shall be a certified Manufacturer's Value Added Reseller (VAR) and/or Authorized Installer and provide an end-to-end product warranty, adhere to the industry standard engineering, installation and testing procedures and utilize the authorized manufacturer components and distribution channels in provisioning this project.

B. Contractor shall coordinate with manufacturer for warranty paperwork and procedures prior to the start of the project.

C. Contractor shall provide a minimum one (1) year warranty on installation and workmanship PLUS an Extended Product Warranty and System Assurance Warranty for this wiring system and shall commit to make available local support for the product and system during the Warranty period.

1. The Extended Product Warranty shall apply to all passive structured cabling system components and shall cover the replacement or repair of defective products and labor for the replacement or repair of such defective products for a minimum of one (1) year.

2. The System Assurance Warranty provides a complete system and product warranty that will be extended to the end-user, ensuring the structured cabling system will be free of defects in materials and workmanship, will meet or exceed applicable performance requirements defined in the contract documents, and support all current and future network applications for a minimum of twenty (20) years.

D. System Certification: Upon successful completion of the installation and subsequent inspection, the customer shall be provided with a numbered certificate, from the manufacturer, registering the installation.

1.15 PAYMENT

A. Refer to the General Contractor contract documents and/or master specifications issued by Architect for project and cost payment details.

1.16 SUBMITTALS

A. Refer to Requirements of Division 1.

B. Refer to Sections 271300 and 271500.

C. The Communications Contractor shall not perform any portion of the work requiring submittal and review of shop drawings, product data, or samples until Owner has approved the respective submittal in writing. Such work shall be in accordance with approved submittals.

D. Pre-Installation Submittal Requirements
1. Communications Contractor shall provide certificates for the appropriate insurance coverage as defined in contract documents.
2. City, county, and/or state telecommunication cabling permits as required by Authority Having Jurisdiction (AHJ).
3. Executed non-disclosure agreement.
4. Appoint a Project Manager and provide the name and contact information.
5. Shop Drawings
   a) Communications Contractor shall submit, for approval, floor plans that identify all device locations, cable routes, cable lengths, cable quantities and cable types, riser locations, and references to installation details and diagrams.
      1) Communication Contractor shall notify Owner of cable routes exceeding standardized lengths.
   b) Communications Contractor shall submit, for approval, diagrams that show room layouts, rack layouts (including elevations), riser layouts, etc.
   c) The Contractor shall make any corrections as required by the consultant team and submit revised shop drawings to the team for approval.
   d) Approval by the Consultant of such drawings or schedules shall not relieve the Contractor from responsibility for deviations from the drawings or specifications, nor shall it relieve the Contractor from responsibility for errors of any sort in shop drawings or schedules. Requests to deviate shall be submitted in writing to the Architect.
6. Product Data Cut-sheets
   a) Communications Contractor shall submit catalogue cut-sheets that include manufacturer, trade name, and complete model number for each product specified. Model number shall be handwritten and/or highlighted to indicate exact selection.
   b) Communications Contractor shall identify applicable specification section reference for each product performance for each component specified for approval prior to purchase and installation.
7. Warranty
   a) The Communications Contractor shall submit appropriate documentation from the certifying manufacturer showing the project is registered and qualified for the System Assurance Warranty.
   b) All subsequent work shall be in accordance with approved submittals. The Communications Contractor shall not perform any portion of the work requiring approval of the System Assurance Warranty manufacturer’s warranty registration qualification procedures that would disqualify any part or all of the wiring system from that warranty qualification.
8. Qualifications
   a) Communications Contractor shall submit a list of the Contractor’s previous projects that demonstrate qualification for this project. This list shall include, but not be limited to:
1) At least ten (10) other projects in the last five (5) years
2) Name and location of project
3) Project contacts, email addresses, and phone numbers
4) Total square footage
5) Total number of cables/drops
6) Types of media

b) Communications Contractor shall submit an up-to-date and valid statement of qualifications for those assigned to perform the work specified herein at time of bid submission.

1) Communications Contractor Employees
2) Subcontractors

c) Manufacturer certifications for Contractor and installers.

9. Cable Testing Plan

a) The Contractor shall provide a complete and detailed test plan for approval of the cabling system specified herein, including a complete list of test equipment for copper and fiber components and accessories prior to beginning cable testing.

b) The following minimal items shall be submitted for review:

1) A testing plan that clearly describes procedures and methods.
2) Product data for test equipment.
3) Certifications and qualifications of all persons conducting the testing.
4) Calibration certificates indicating that equipment calibration meets National Institute of Standards and Technology (NIST) standards and has been calibrated at least once in the previous year of the testing date.
5) Examples of test reports, including all graphs, tables, and charts necessary for display of testing results.

10. Samples

a) For workstation outlet connectors, jack assemblies, housings and faceplates for color selection and evaluation of technical specifications and requirements. Confirm with Architect, interior designer, and Owner representative for color before purchasing materials.

E. Closeout Submittal Requirements

1. As-Built Drawings

a) Communications Design drawings are to be supplied to the Architect to prepare the master “As-Built” drawings.

b) Submit one electronic copy and one hard copy with project deliverables within three (3) weeks subsequent to substantial completion. Provide a laminated floorplan with drop designations in the respective serving Telecom Room.

c) As-Built drawings shall be in AutoCAD format, same version as used by Architect and consultant. Dimensions and scale of the drawing sheets submitted shall match the size of the drawing sheets used for the contract documents.
d) Utilize normal recognized drafting procedures that match AutoCAD standards, Architect and Consultant guidelines, and methodology.

e) The As-Built drawings shall incorporate all changes made to the building identified in, but not limited to, addendum, change notices, site instructions or deviations resulting from site conditions.

1) Contractor shall clearly identify any resubmitted drawing sheets, documents or cut sheets either by using a color to highlight or cloud around resubmitted information.

2) Maintain drawing numbering or page/sheet scheme consistency as per previously issued drawings/documents.

f) Provide dimensioned plan and elevation views of networking components, showing:

1) All work area outlet locations complete with outlet/cable labeling.

2) Rack and/or cabinet locations complete with labeling.

3) One-line diagram of equipment/device interconnections with the cable plant.

4) Standard or typical details of installations unique to Owner’s requirements.

2. The Communications Contractor shall deliver the Installer’s Extended Product Warranty and Manufacturer’s signed System Assurance Warranty of installed cabling system to include all components that comprise the complete cabling system.

a) Delivery shall be completed within two (2) weeks of the time of final punch list review.

b) Product Certificates shall be signed by manufacturers of cables, connectors, and terminal equipment certifying that products furnished comply with requirements.

3. Cable Testing Report Requirements

a) Submit certified test reports of Contractor-performed tests. Contractor shall submit the required Test Reports in the format and media specified, upon completion of testing the installed system.

b) The tests shall clearly demonstrate that the media and its components fully comply with the requirements specified herein.

c) Three (3) sets of electronic and hardcopy versions of test reports shall be submitted together and clearly identified with cable designations.

d) Cable inventory data shall be submitted for all fiber, copper, and coaxial cabling and termination components. Include products furnished:

1) Manufacturer’s name

2) Manufacturer’s part numbers

3) Cable designations

4) Location and riser assignments

5) Product Data

4. Supply Owner with training manuals with instructions on methods of adding or removing cabling to/from firestopped sleeves and chases.
F. The Contractor’s BICSI Registered Communications Distribution Designer (RCDD) supervisor shall review, approve and stamp all documents prior to submitting. The Contractor’s RCDD shall warrant in writing that 100% of the installation meets the requirements specified herein upon completion of all work.

PART 2 - PRODUCTS

2.1 SUMMARY

A. Equipment and materials shall be standard products of a manufacturer regularly engaged in the manufacture of telecommunications cabling products and shall be the manufacturer’s latest standard design in satisfactory use for at least one year prior to bid opening.

B. All material and equipment, as provided, should be the standard Commercial-Off-The-Shelf (COTS) products of a manufacturer engaged in the manufacturing of such products.
   1. All shall be typical commercial designs that comply with the requirements specified.
   2. All material and equipment shall be readily available through manufacturers and/or distributors.

C. All equipment shall be standard catalogued items of the manufacturer and shall be supplied complete with any optional items required for proper installation.

D. Coordinate the features of materials and equipment so they form an integrated system. Match components and interconnections for optimum future performance and backward compatibility.

E. All materials shall be UL- and/or ETL-approved and labeled in accordance with NEC for all products where labeling service normally applies.

F. Materials and equipment requiring UL 94, 149 or 1863 listing shall be so labeled. Modification of products that nullifies UL labels is not permitted.

G. Backward Compatibility: The provided products shall be backward compatible with lower category ratings such that if higher category components are used with lower category components, the basic link and channel measures shall meet or exceed the lower category’s specified parameters.

H. Component Compliance: The provided products shall each meet the minimum transmission specifications listed herein such that no individual component will be less than specifications for permanent link and channel, regardless of the fact that tests for link and channel ultimately meet required specifications.

2.2 ACCEPTABLE MANUFACTURERS

A. Identification (Labeling) System
   1. Brady
   2. Dymo
   3. Hellerman-Tyton
   4. Acceptable alternate

B. Fire-Stop Systems
1. Specified Technologies sleeve kit with firestop putty 1-inch  FS100
2. Specified Technologies sleeve kit with firestop putty 2-inch  FS200
3. Specified Technologies sleeve kit with firestop putty 4-inch  FS400
4. Hilti CP618 Firestop Putty  3474775

C. Other Products as Referenced in other Division 27 Specifications.

PART 3 - EXECUTION

3.1 PREPARATION

A. Field Measurements

1. Verify dimensions in areas of installation by field measurements before fabrication and indicate measurements on shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the work.

B. Established Dimensions

1. Where field measurements cannot be made without delaying the work, coordinate with the General Contractor to establish dimensions.
2. When approved in writing, proceed with fabricating units without field measurements.
3. Coordinate supports, adjacent construction, and fixture locations to ensure actual dimensions correspond to established dimensions.

C. Pre-installation inspection

1. The Contractor shall visually inspect all cables, cable reels, and shipping cartons to detect possible cable damage incurred during shipping and transport.
2. Visibly damaged goods are not acceptable and shall be replaced by the contractor at no additional cost to the Owner.

3.2 INSTALLATION

A. General

1. Contractor shall install work in accordance with specifications, drawings, manufacturer's instructions and approved submittal data.

B. Allowable cable bend radius and pull tension:

   a) In general, communications cable cannot tolerate sharp bends or excessive pull tension during installation.

   b) Refer to cable manufacturer's bend radius recommendations for the maximum allowable limits.

   c) After installation, exposed cable and other surfaces must be cleaned free of lubricant residue. Use only lubricants specifically designed for cable installation.

C. Pull Strings
1. Provide pull strings in all new conduits, including all conduits with cable installed (trailer strings) as part of this contract.
2. Data and video cables can be pulled in tandem with pull strings.
3. The pull strings must move freely to prevent cable jacket/cable damage during pulls.

D. Labeling

1. Cable labels: Self-adhesive vinyl or vinyl-cloth wraparound tape markers, machine printed with alphanumeric cable designations.
2. Flat-surface labels: Self-adhesive vinyl or vinyl-cloth labels, machine printed with alphanumeric cable designations.
3. Provide transparent plastic label holders, and 4-pair marked colored labels.
4. In accordance with ANSI/TIA-606-C "Administration Standard for Commercial Telecommunications Infrastructure":
   a) Install colored labels according to the type of field as per color code designations.
   b) Use "designation strip color-code guidelines for voice, data, cross-connect, riser, and backbone fields".

5. Pathway Labels and Labeling System

   a) Labeling system shall consist of a hand-held portable printer
   b) Conduits: General-purpose label designed for powdered coated surfaces with an ultra-aggressive adhesive. Label size shall be appropriate for the conduit size. Font size shall be legible from the finished floor.
   c) Inner duct: Polyethylene general-purpose tagging material attached using tie wraps.
   d) Junction boxes: General-purpose label designed for powdered coated surfaces with an ultra-aggressive adhesive, trade name. Font size shall be easily visible from the finished floor.
   e) All labels shall be permanent, i.e. will not fade, peel, or deteriorate due to environment or time.
   f) Identification
      1) All conduits, junction boxes, gutters, and pull boxes shall have machine-generated labels easily visible from the finished floor.
      2) Conduits shall be labeled with the word “communications” and the conduit’s origination room number and destination room number.
      3) The Contractor shall label conduit at each wall and floor penetration and at each conduit termination, such as outlet boxes, pull boxes, and junction boxes, or as otherwise specified in other sections.
      4) Junction boxes, gutters and pull boxes shall be labeled with identification name or number as determined by contractor and submitted for approval.
      5) The Contractor shall label conduit sleeves at each wall and floor penetration.

E. Firestop
1. Provide approved fire-resistant materials to restore originally-designed fire-ratings to all wall, floor, and ceiling penetrations used in the distribution and installation for communications cabling system.

2. Install and seal penetrations (conduit, sleeves, slots, chases) in fire-rated barriers created for communications infrastructure to prevent the passage of smoke, fire, toxic gas, or water through the penetrations.

3. The firestopping material shall maintain/establish the fire-rated integrity of the wall/barrier that has been penetrated.

4. All through penetrations in a fire rated surface require a sleeve, regardless of penetration diameter or penetrating cable count.

5. Using a “ring and string” method of installing cabling for membrane penetrations in a wall cavity is acceptable, provided the solution was accepted by the Owner in writing. Code-compliant firestopping rules still apply.

6. Coordinate firestopping procedures and materials with General Contractor.

7. Sharing the pathway of other trades/utilities through compliant and non-compliant penetrations does not remove the requirement to maintain code-compliant firestopping.

8. Provide and install removable, intumescent mechanical systems in floor chases for all openings greater than 0'-4”.

9. Provide and install removable, intumescent, firestop bricks for all openings greater than 0'-4” where there are penetrations through walls.

10. Bricks shall be listed for insertion in fire-rated openings and require restraining materials or apparatus as needed per manufacturers’ specifications.

11. Provide manufacturer recommended material for rated protection for any given barrier.

12. Laminate and permanently affix adjacent to chases the following information:

   a) Manufacturer of firestop system.

   b) Date of installation/repair.

   c) Part and model numbers of system and all components.

   d) Name and phone numbers of local distributor and manufacturer's corporate headquarters.

13. Solutions and shop drawings/submittals for firestop materials and systems shall be presented to the General Contractor for written approval of materials/systems prior to purchase and installation.

14. Materials shall be installed per manufacturer instructions, be UL-listed for intended use, and meet NEC and locals codes for fire stopping measures.

15. The material chosen shall be distinctively colored to be clearly distinguishable from other materials, adhere to itself, and maintain the characteristics for which it is designed to allow for the removal and/or addition of communication cables without the necessity of drilling holes in the material.

16. Develop training manuals with instructions on methods of adding or removing cabling to/from firestopped sleeves and chases.

F. Within the normal environment, the installed systems shall not generate nor be susceptible to any harmful electromagnetic emission, radiation, or induction that degrades, or obstructs any equipment.

G. Expansion Capability: Unless otherwise indicated, provide spare conductor pairs in cables, positions in patch panels, cross connects, and terminal strips, and space in cable pathways and backboard layouts to accommodate 20% future increase in structure cable system capacity.
H. In the event of a breach of the representations and warranties contained herein, the Contractor, at their own expense, shall take all measures necessary to make the cabling system work and comply with the applicable manufacturer written technical recommendations and standards.

I. System Tests

1. Upon completion of the installation of the communications infrastructure systems, including all pathways and grounding, the Contractor shall test the system.

   a) Cables and termination modules shall be affixed, mounted or installed to the designed/specified permanent location prior to testing.

   b) Any removal and reinstallation of any component in a circuit, including faceplates, shall require retesting of that circuit and any other disturbed or affected circuits.

   c) Approved instruments, apparatus, services, and qualified personnel shall be utilized.

   d) The Contractor must verify that the requirements of the specifications are fully met through testing with an approved tester (rated for testing parameters listed elsewhere), and documentation as specified below.

   e) This includes confirmation of requirements by demonstration, testing and inspection. Demonstration shall be provided at final walk-through in soft copy and printed test data.

2. Non-Compliant Cabling

   a) Testing that shows some or all pairs of a cable do not comply with specifications, without written approval by the Owner, shall be replaced at Contractor’s expense (including respective connectors).

   b) With the Owner’s written approval, the over-length cable(s) shall be excluded from requirements to pass standardized tests and shall be explicitly identified.

      1) Testing is still required for non-compliant cabling.

      2) The tests shall be for wire-mapping, opens, cable-pair shorts, and shorts-to-ground.

      3) The test results must be within acceptable tolerances and shall be submitted with the Owner’s acceptance document.

3. Failed Tests

   a) If tests fail, Contractor shall correct as required to produce a legitimate passing test.

   b) Manipulation of tester parameters on a failing test in order to achieve a passing test is unacceptable.

   c) If the Contractor is found to have manipulated or falsified any failing test result to show a “PASS” for any reason (without written notice and prior approval of the Owner), the Contractor shall be required to employ a Third-Party Testing Agent selected by the Owner to retest the complete cable plant and shall be required to pay all costs associated with this retesting.

4. Owner reserves the right to be present during any or all testing.
3.3 CLEANING

A. The Contractor will clean all surfaces prior to final acceptance by Owner.

3.4 COMPLETION INSPECTION AND PUNCH LIST

A. When the Contractor determines that the Scope of Work has been completed in accordance with the plans and specifications, Contractor shall schedule a Completion Inspection with the Owner.

B. A Punch List will be generated during the Completion Inspection containing deficiencies in need of corrective action.

C. Complete all punch list deficiencies within 10 working days. The work is not complete until all punch list deficiencies have been addressed.

3.5 ACCEPTANCE

A. Once all work has been completed, test documentation has been submitted, and Owner is satisfied that all work is in accordance with contract documents, the Owner shall notify Contractor in writing of formal acceptance of the system.

B. Contractor must warrant in writing that 100% of the installation meets the requirements specified herein (Standards Compliance & Test Requirements).

C. Acceptance shall be subject to completion of all work, successful post-installation testing which yields 100% PASS rating, and receipt of full documentation soft and hard copies as described herein.

END OF SECTION
SECTION 27 0526
GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY
A. This section includes grounding and bonding products, design requirements and installation for communications systems.
B. Related Sections
1. Section 260000 Electrical (including related sub-sections)
2. Section 270000 Communications
3. Section 270528 Pathways for Communications Systems
4. Section 271100 Communications Equipment Room Fittings
5. Section 271300 Communications Backbone Cabling
6. Section 271500 Communications Horizontal Cabling
7. Section 274100 Audio-Visual Systems
8. Section 280000 Electronic Security (including related sub-sections)

1.2 REFERENCES
A. The publications referenced in Section 270000 form a part of this specification. The publications are referred to in the text by basic designation only.
B. Specific reference in specifications to codes, rules, regulations, standards, manufacturer’s instructions, or requirements of regulatory agencies shall mean the latest printed edition of each in effect at the date of contract unless the document is shown dated.
C. Conflicts
1. Refer to Section 270000.
D. Codes and Standards
1. Refer to Section 270000.

1.3 SYSTEM REQUIREMENTS
A. General
1. All conductor wire, busbars and conduit shall be UL listed.
2. The communications ground system shall be independent from all power grounding except for the connection to the building’s electrical service main grounding electrode system.
3. Power grounding and/or bonding shall not be allowed to interfere or provide any back feed or be a conductor to the separate communications ground system source or to any communications bonded materials or equipment.
B. Telecommunication Bonding Backbone (TBB) and Secondary Bonding Busbar (SBB)

1. The Telecommunication Bonding Backbone (TBB) originates at the PBB and shall be extended from the PBB within the ER (MDF) throughout the building along the same route as the telecommunications backbone pathways, to the Secondary Bonding Busbar(s) (SBBs) in each TR (IDF).

2. The minimum TBB conductor size between busbars shall be a stranded copper ground wire one (1) AWG size smaller than the Telecommunications Bonding Conductor (TBC).

C. TEBC and RBC

1. All cabinets and racks shall be connected by the Telecommunications Equipment Bonding Conductor (TEBC). The TEBC is a stranded copper #4 conductor from the PBB/SBB extending along each row of racks within the room. Bond each rack with a Rack Bonding Conductor (RBC). The RBC is a stranded copper #6 conductor connected to the vertical rack bonding terminal. All connections shall be irreversible crimp connections. Route conductor so as to minimize the quantity of sweeping bends.

1.4 SUBMITTALS

A. Refer to Section 270000.

1.5 QUALITY ASSURANCE

A. Refer to Section 270000.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 270000.

B. The Contractor shall ship on manufacturer’s standard reel sizes of one continuous length. Where cut lengths are specified, mark reel quantity accordingly.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, manufacturers that may be incorporated in the work, include:

B. Cable Manufacturers

1. Houston Wire and Cable Company
2. Okonite Company
3. General Cable
4. Pirelli Cable Corporation
5. Triangle Wire and Cable
6. Owner Approved Alternate
C. Electrical Service Entrance Bonding Conductor and Connector Manufacturers
   1. Copperweld
   2. Thomas & Betts
   3. Blackburn
   4. Owner Approved Alternate

D. Exothermic Connector Manufacturers
   1. Erico Products (Cadweld)
   2. Continental Industries (thermOweld)
   3. Harger
   4. Owner Approved Alternate

E. Crimp Connector Manufacturers
   1. Thomas & Betts
   2. FCI Burndy Electrical
   3. O-Z/Gedney
   4. Owner Approved Alternate

F. Telecommunication Grounding Busbars
   1. Chatsworth
   2. Panduit
   3. Leviton
   4. Owner Approved Alternate

G. Bonding Straps
   1. Chatsworth
   2. Harger
   3. Brundy
   4. Owner Approved Alternate

H. C-Type Compression Taps
   1. Brundy
   2. Harger
   3. Owner Approved Alternate

I. Antioxidant Joint Compound
   1. Chatsworth
   2. Owner Approved Alternate

J. Labeling
   1. Refer to Section 270000.

K. Firestopping
   1. Refer to Section 270000.
2.2 MATERIALS

A. Communications Grounding Conductors: Copper American Wire Gauge (AWG) wire of the following sizes:

1. Telecommunications Bonding Conductor (TBC): #4/0 (unless otherwise sized by the Electrical Engineer of Record)
2. Telecommunication Bonding Backbone (TBB): #3/0 (unless otherwise sized by the Electrical Engineer of Record)
3. Backbone Bonding Conductor (BBC): equal AWG as the TBB (unless otherwise sized by the Electrical Engineer of Record)
4. Telecommunications Equipment Bonding Conductor (TEBC): #4
5. Rack Bonding Conductor (RBC): #6

B. Grounding Connectors

1. Connectors shall be a copper alloy material and two-hole, double-crimp compression lug type at the connecting ends.

C. Secondary Bonding Busbar (SBB)

1. Use pre-drilled copper busbar with standard NEMA bolt hole sizing and spacing for the type of connectors.
2. Sized for the immediate requirements and allow for 25% growth.
3. The minimum dimensions shall be 0’-¼” thick X 0’-4” wide X 0’-10”/1-0” long.
4. Contain (2) tiers of pre-drilled holes for use with standard sizes of two-hole copper compression lugs.
5. ASTM-B187-C11000 Copper bar suitable for use with two-hole compression type copper lugs.

D. Equipment Cabinet and Rack Bonding Busbar (RBB)

1. Provide and install a vertical ground busbar in all racks and equipment cabinets to be used as an equipment grounding bus with associated mounting hardware.
2. The minimum dimensions shall be 0’-¾” in width by 0’-3/16” in thickness.
3. The busbar shall have pre-drilled holes and shall be suitable for use with two-hole compression-type copper lugs.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Refer to Section 270000.

3.2 PREPARATION

A. Refer to Section 270000.

B. Copper and copper alloy connections should be cleaned prior to connection.
3.3 INSTALLATION

A. Refer to Section 270000.

B. The Contractor shall install the work in accordance with the specifications, drawings, manufacturer’s instructions and approved submittal data.

C. All work shall be supervised and reviewed by the Contractor’s on-site RCDD.

D. Installation plans and Requests For Information (RFIs) shall be reviewed by the Contractor’s RCDD.

E. General

1. Bonding and grounding procedures and components shall comply with ANSI/TIA-607-C “Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications”.
2. Bonding should be accomplished such that the bonding system is integrated and compliant with NEC specifications.
3. Bonding conductors shall be routed with minimum bends or changes in direction and should be made directly to the points being bonded.
4. Bonding connections should be made by using compression copper lugs. However, for parts of the ground electrode system that are subject to corrosion, must carry high currents reliably, or for locations that require minimum maintenance, connections are made with low emission exothermic welding (see NEC Article 250).
5. Make connections to dry surfaces only.
6. Remove paint, rust, oxides, scales, grease and dirt from surfaces before making connection.
7. Burnish clean a 0'-1" X 0'-1" area, drill, tap, apply an adequate amount of antioxidant joint compound mixed for the metal surface types affected, and bolt conductor and connector to burnished and compounded area. Ensure proper conductivity.
8. Route bonding conductor(s) the shortest distance between bonding contact points.
9. The ground-wire connecting ends shall have a minimum amount of insulation removed at the ground lug.
10. Do not connect ground wire in power cable assemblies to the telecommunications ground system.
11. All grounding and bonding conductors shall be copper and may be insulated. If bare-bonding conductors are used, isolate bonding conductors and prevent contact.
12. Antioxidant material shall be installed to separate dissimilar metals and prevent corrosion.
13. If multiple systems are involved (lightning protection systems, communications, radio and TV, CATV, etc.), those systems shall be bonded together to minimize potential differences between the systems, per NEC 250.94.

F. Telecommunication Bonding Conductors

1. Each telecommunications grounding and bonding conductor shall be labeled at each end detailing the function and room number of its opposite end. Labels shall be located on conductors as close as practicable to their point of termination in a readable position. Labels shall be nonmetallic and include the following text, “TELECOMMUNICATIONS GROUND - DO NOT REMOVE. IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATIONS MANAGER”.
2. Furnish and install all required bonding material, hardware, and utilize tools manufactured for this purpose.
3. The connections of the TBC, TBB, BBC, TEBC, and RBC shall be made using low emission exothermic welding or hydraulically crimped with a double crimp connector. Two-hole grounding lugs are preferred for connection to the grounding bus bars.
   a) All low emission exothermic welding shall be by Division 26.
   b) Coordinate with the building services personnel in occupied spaces to prevent the smoke from the exothermic weld process from potentially setting off smoke/fire alarms.

4. Grounding and bonding conductors should not be placed in ferrous metallic conduit. If it is necessary to place grounding and bonding conductors in a ferrous metallic conduit that exceeds 1m (3ft) in length, the conductors shall be bonded to each end of the conduit using a grounding bushing or a No. 6AWG conductor, minimum.

5. The bonding conductors should be installed without splices.
   a) Where splices are necessary, the number of splices should be minimized, be accessible, and be located within the telecommunications spaces.
   b) Joined segments of a bonding conductor shall be connected using exothermic welding, irreversible compression-type connectors, or equivalent. All joints shall be adequately supported and protected from damage.

G. Equipment Cabinets and Racks

1. The busbar shall be installed at the base and back of each cabinet/rack for floor fed cabinets/racks.
2. The busbar shall be installed at the top and back of each cabinet/rack for top fed cabinets/racks.
3. Each cabinet and rack shall be provided with a minimum # 6 AWG ground wire.
4. Do not loop from cabinet/rack to cabinet/rack.
5. Each cabinet or rack bay against the wall shall be bottom/side ground fed from the wall.
   a) Wall ground feeds/raceways to racks shall not be exposed on the walls.
   b) Exception: Some cabinet or rack bays will require the ground to be fed from the ceiling raceway.

6. All ground raceways within each cabinet/rack or cabinet base and adjacent-ganged cabinet base shall be an insulated metallic flex type raceway and shall not interfere with equipment mounting frames or equipment mounting brackets.

H. Cable Runway, Cable Raceway and Support System Grounding

1. The Contractor shall provide communications cable tray and cable runway systems with a communications dedicated ground from the SBB.
2. All cable tray needs to be electrically continuous per NEC 250.96.
   a) Metal raceways, wire-mesh cable trays, cable armor, cable sheath, enclosures, frames, fittings, and other metal non-current-carrying parts that are to serve as an alternate grounding path, with or without the use of supplementary equipment grounding conductors, shall be effectively bonded where necessary to ensure electrical continuity and the capacity to conduct safely any fault current plausibly to be imposed on them.
b) Any nonconductive paint, enamel, or similar coating shall be removed at the threads, contact points, and contact surfaces.

c) Grounding or bonding conductors shall be connected by fittings designed for that purpose to ensure adequate bonding.

3. The Contractor shall provide and install a #6 AWG ground wire to bond one end of each cable tray/runway system to the SBB.

4. For electrically non-continuous conduits that contain only grounding conductor, the Contractor shall bond the conduit and conductor together at both ends to ground to the nearest TGB with grounding bushings or ground clamps.

I. Shielded Backbone Cabling

1. The Contractor shall terminate and bond the shield to the nearest SBB or PBB at both ends, following manufacturer’s guidelines.

3.4 FIELD QUALITY CONTROL

A. Testing

1. Upon completion of the electrical system, including all grounding, the Electrical Contractor shall test the system for stray currents, ground shorts, etc.

2. Approved instruments, apparatus, services, and qualified personnel shall be utilized.

3. If stray currents, shorts, etc., are detected, eliminate or correct as required.

END OF SECTION 270526
SECTION 270528

PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. Hangers and Supports, including open-top supports (cable hooks) for communications systems.
2. Conduits and Pull Boxes for communications systems.
3. Cable Tray and Cable Runway with associated accessories and fittings for communications systems.

B. Related Sections

1. Section 260000 Electrical (including related sub-sections)
2. Section 270000 Communications Systems
3. Section 270526 Grounding and Bonding for Communications Systems
4. Section 271100 Communications Equipment Room Fittings
5. Section 271300 Communications Backbone Cabling
6. Section 271500 Communications Horizontal Cabling
7. Section 274100 Audio-Visual Systems
8. Section 280000 Electronic Security (including related sub-sections)

1.2 REFERENCES

A. The publications referenced in Section 270000 form a part of this specification. The publications are referred to in the text by basic designation only.

B. Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean the latest printed edition of each in effect at the date of contract unless the document is shown dated.

C. Conflicts

1. Refer to Section 270000.

D. Codes and Standards

1. Refer to Section 270000.

1.3 SUBMITTALS

A. Refer to Section 270000.
1.4 QUALITY ASSURANCE
   A. Refer to Section 270000.

1.5 DELIVERY, STORAGE, and HANDLING
   A. Refer to Section 270000.
   B. Conduit Storage
      1. Package conduits in bundles maximum 10'-0" long, with conduit and coupling thread
         protectors for indoor/outdoor storage.
      2. Package fittings in manufacturer's standard quantities and packaging suitable for indoor
         storage.
      3. Protect coating on plastic-coated rigid conduit, fittings, and bodies from damage during
         shipment and storage.
      4. Store conduit above ground on horizontal racks to prevent corrosion and entrance of
         debris.
      5. Equipment and components shall be protected from the weather, humidity, temperature
         variations, dirt, dust, or other contaminants. Protect plastic conduit and inner duct from
         sunlight. Equipment damaged prior to system acceptance shall be replaced at no cost to
         the Owner.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS
   A. Subject to compliance with requirements, manufacturers that may be incorporated in the work,
      include:
   B. Cable Hooks
      1. Panduit 2" J-hook with clip for drop wire or threaded rod JP2W-L20DW
      2. Panduit 3/4" J-hook with clip for drop wire or threaded rod JP75W-L20DW
      4. Hilti 6-foot pretied grid wire with 1-inch nail (bundle of 100)2044902
      5. Owner approved alternate
   C. Cable Tray
      1. Panduit WG18BL10
      2. Owner approved alternate
   D. Measured pull tape (pull tape printed with sequential footage markings)
      1. Fibertek
      2. Condux International
      3. Owner approved alternate
   E. Labeling
1. Refer to Section 270000.

2.2 CABLE HOOKS

A. Cable hooks shall be factory assembled for direct attachment to walls, hanger rods, beam flanges, purlins, strut, floor posts, etc. to meet job conditions.

B. Features

1. Cable hooks shall have a flat bottom and provide a minimum of 0’-1.625” cable-bearing surface.
2. Cable hooks shall have 90° radius edges to prevent damage while installing cables.
3. Cable hooks shall be designed so that the mounting hardware is recessed to prevent cable damage.
4. Cable hooks for non-corrosive areas shall be pre-galvanized steel. Where additional strength is required, cable hooks shall be spring steel with a zinc-plated finish.
5. Cable hooks for corrosive areas shall be stainless steel.
6. Cable hooks shall have a stainless steel cable latch retainer to provide containment of cables within the hook.
7. The retainer shall be removable and reusable.

C. Factory assembled multi-tiered cable hooks shall be used where required to provide separate cabling compartments, or where additional capacity is needed.

D. Load cable hooks in accordance with manufacturer requirements and recommendations.

E. Provide capacity for 25% growth, add additional hooks as needed.

2.3 PULL BOXES, JUNCTION BOXES, AND GUTTERS

A. All junction boxes, gutters and pull boxes shall be UL listed and comply with NEC requirements.

B. All junction boxes, gutters and pull boxes shall meet the following minimum material requirements:

1. 16-gauge steel or heavier
2. Seams shall be continuously welded and grounded smooth
3. External screws and clamps
4. External mounting feet (where applicable)
5. Oil-resistant gasket and adhesive
6. ANSI 61 gray polyester powder coating inside and out over phosphatized surface

C. All junction boxes, gutters and pull boxes shall be provided with bushings for conduits and/or cabling.

D. All junction boxes, gutters and pull boxes shall be securely installed.

2.4 CONDUITS

A. All conduits shall be UL listed and comply with NEC requirements.

B. Conduit Fittings
1. All fittings shall be compression or threaded.
2. Fittings shall provide a secure connection for pulling communications cables.
3. Setscrew fittings are not permitted.
4. Conduit “condulets” are not permitted.

C. Non-metallic conduits are not permitted in above ground installations. Conversion fittings are required for non-metallic (below ground) to metallic (above ground) transitions.

D. Innerduct:
1. All fiber shall be installed in innerduct unless fiber cabling is armored.
2. Shall be constructed of non-metallic material.

E. Only manufacturer’s fittings, transition adapters, terminators and fixed bends shall be used.

F. Measured Pull Tape
1. Pre-lubricated, woven polyester, low friction, and high abrasion resistant yarn with footage markers printed on the tape.
2. Minimum average tensile strength shall be 1130 lbs. for 0’-1.5” and smaller conduits and innerduct.
3. Minimum average tensile strength shall be 1800 lbs. for conduits larger than 0’-1.5”.

G. Fill and Bend Radius
1. Conduit fill shall comply with NEC requirements.
2. The minimum bend radius is 6 X the conduit inside diameter (ID) for 0’-2” conduit or less.
3. The minimum bend radius is 10 X the conduit ID for a conduit greater than 0’-2”.
4. There shall be no more than two 90° bends (180° total) between conduit pull boxes.
5. Changes in direction shall be accomplished with sweeping bends observing minimum bend radius requirements above.
6. Do not use pull boxes for direction changes unless specifically designated otherwise in the drawings.
7. Unless otherwise noted in the drawings, conduits entering pull boxes shall be aligned with exiting conduits.

H. Routing
1. Conduits shall be routed in the most direct route possible, with the fewest number of bends possible.
2. There shall be no continuous conduit sections longer than 100’-0” for premises conduits. For runs that total more than 100’-0”, insert junction or pull boxes so that no continuous run between pull boxes is greater than 100’-0”.

I. Penetrations
1. All conduit penetrations shall comply with all applicable fire codes.
2. All conduit penetrations in fire-rated walls or floors shall be sealed and fire-proofed to meet or exceed the designed rating of the penetration area.

2.5 CABLE TRAY
A. Cable tray systems are defined to include, but are not limited to, straight sections of cable trays, bends, tees, elbows, reducers, crosses, wyes, vertical bends, up/down tees, cable support fittings, drop-outs, supports and accessories.

B. Install all tray types utilizing manufacturer recommended installation instructions and applicable standards.

C. Load cable tray and cable runway in accordance with manufacturer requirements and applicable standards.

D. Cable trays shall have sufficient depth and width so as not to exceed a maximum 50% fill ratio, including 25% capacity for anticipated growth.

E. All straight sections shall be supplied in minimum 8'-0" lengths, except where shorter lengths are permitted to facilitate tray assembly lengths.

2.6 HANGERS AND SUPPORT

A. Steel support brackets shall be galvanized steel and capable of supporting a minimum of 200 lbs with a safety factor of 3.

B. Steel support brackets shall have a removable galvanized steel retaining strap.

C. Steel support brackets shall accept 0'-3/8" (10mm) threaded rod for attachment to building structure or sub structure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Refer to Section 270000.

3.2 PREPARATION

A. Refer to Section 270000.

B. Verify system is properly sized for cables before installation.

C. Verify that the manufacturer recommended loads are not exceeded.

D. Verify general routing and coordinate locations with other trades before installation. Layout cable runs in advance to determine quantities of cable to be installed along pathways, and to ensure non-interference from other trade installations.

3.3 INSTALLATION

A. Refer to Section 270000.

B. Cable Hooks
1. Provide cable hook (j-hook) cable support system for horizontal and/or riser cabling in accessible ceiling space. Assemblies shall be complete with mounting hardware.
2. Provide threaded rod for supporting hangers when hanging from floor deck and deck members.
3. Follow manufacturers fill capacities.
4. Locate cable hooks on 4’ to 5’ centers to adequately support and distribute the cable’s weight.
5. Suspended cables shall be installed with at least 0’-3” of clear vertical space above the ceiling tiles and support channels.
6. For larger quantities of cables, provide special supports that are specifically designed to support the required cable weight and volume.
7. Do not support pathways or cables with the ceiling suspension system or use electrical, plumbing, or other pipes for support.
8. Cable supports shall be permanently anchored to building structure or substrates. Provide attachment hardware and anchors designed for the structure to which attached, and that are suitably sized to carry the weight of the cables to be supported.
9. Secure and support exposed horizontal cable at intervals not exceeding 5’-0” and not less than 1’-4” (16”) from cabinets, pack pole, boxes, fittings, outlets, racks, frames, and terminals.
10. Cable sag between vertical supports for horizontal pathway shall not exceed 0’-6”. Provide at least 0’-3” cable sag between supports.
11. Painted J-hooks shall meet or exceed NEC requirements for the environment in which the product is installed.

C. Conduit and Pull Boxes

1. The Contractor shall route the conduit in approximate locations unless drawing is dimensioned for precise placement.
2. Conduit cuts shall be square. Ream ends of burrs and remove metal shavings and cutting lubricants before conduit is connected to the conduit system.
3. For conduit embedded in concrete, coat threaded connections in conduits with colloidal rust and corrosion inhibitor and sealant. Conduit must be clean and dry and must pass standard sizing test after concrete is poured.
4. Cap unused conduits with watertight caps
5. Make conduit connections with appropriate fittings and tighten securely.
6. Use appropriate tools to install PVC coated conduit; avoid damage to exterior coating.
7. Install liquid-tight flexible metal conduit where exposed to weather, water, or other liquids.
8. Use IMC, PVC conduit, or rigid galvanized steel conduit in underground installations.

D. Innerducts

1. The Contractor shall provide fabric innerduct in all underground conduits, as indicated on the drawings.
   a) The Contractor shall use pre-lubricated, woven polyester, low friction, and high abrasion resistant fabric.
   b) The Contractor shall be trained for proper installation technique by the innerduct manufacturer. The Contractor shall coordinate with the owner to demonstrate that pull ropes in each inner duct cell move freely from end to end.

E. Cable Tray and Cable Runway

1. Cut wire basket tray members square with approved cable tray cutting tool as to not leave sharp edges at cut point. Remove burrs and smooth the ends before the cut is connected to wire-mesh tray system.
2. Ensure that standard splices are designed to have less than 1 milliohm (0.0001 Ω) of resistance between connections and provide bonding between sections. Painted wire mesh tray requires the outer mask of the non-conductive surface be removed at each end of the tray prior to installing the splice to provide continuity between painted tray sections.

3. Threaded rod (minimum 0"-½" diameter) or equivalent and slotted channel shall be used for hanging cable tray between floor deck and deck members

F. Fiber Support:

1. Support vertical fiber optic cable with basket weave wire/cable grips. Support fiber riser with single weave support grip with a single offset eye.
2. Mount/attach pulling eye to a wall or ceiling deck secured hook to support/provide strain relief to riser cable. Provide a minimum 3'-0" loop of fiber prior to entering fire stopped floor sleeve.
3. Where required coil up slack fiber cable into pull box and secure with single weave support grip.

G. Clearances

1. A minimum of 1'-0" access headroom shall be provided above a cable tray. Ensure that other building components do not restrict access to the cable trays from the sides.
2. Power outlets shall not be installed in or mounted to cable tray or cable runway.
3. Provide 3'-0" of unencumbered space for every 10'-0" segment of tray.
4. Cable tray clearances
   a) Motors or transformers: 4'-0"
   b) Power cables and conduit: 1'-0"
   c) Fluorescent lighting: 0'-5"
   d) Halide lights: 1'-0"
   e) Above the ceiling tiles: 0'-3"
   f) Access above and on one side of the cable tray: 1'-0"

3.4 FIELD QUALITY CONTROL

A. Test system to ensure electrical continuity of bonding and grounding connections.

B. Ensure compliance with specified maximum ground resistance.

3.5 CLEANING

A. Remove all unnecessary tools and equipment, unused materials, packing materials, and debris from each area where Work has been completed unless designated for storage.

B. Wipe clean all cable trays and apply appropriate manufacturer’s paint to areas that have been scratched.

END OF SECTION 270528
SECTION 27 1100

COMMUNICATIONS ROOM FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes basic communications and equipment room design requirements and fittings including:
   1. Equipment cabinets, racks, frames and enclosures
   2. Cable management and ladder racks
   3. Telecommunications service entrance pathways
   4. Rack mounted power protection and power strips

B. Related Sections

1. Section 260000 Electrical (including related sub-sections)
2. Section 270000 Communications
3. Section 270526 Grounding and Bonding for Communications Systems
4. Section 270528 Pathways for Communications
5. Section 271300 Communications Backbone Cabling
6. Section 271500 Communications Horizontal Cabling
7. Section 280000 Electronic Security (including related sub-sections)

1.2 REFERENCES

A. The publications listed below form a part of this specification. The publications are referred to in the text by basic designation only.

B. Specific reference in specifications to codes, rules, regulations, standards, manufacturer’s instructions, or requirements of regulatory agencies shall mean the latest printed edition of each in effect at the date of contract unless the document is shown dated.

C. Conflicts

1. Refer to section 270000.

D. Codes and Standards (Most recent editions or as required in contract)

1. Refer to section 270000.

1.3 SUBMITTALS

A. Refer to section 270000.

1.4 QUALITY ASSURANCE
A. Refer to section 270000.

B. Product Standards

1. Equipment and materials shall be standard products of a manufacturer regularly engaged in the manufacture of telecommunications cabling products and shall be the manufacturer’s latest standard design in satisfactory use for at least one year prior to bid opening.

2. Items of the same classification shall be identical. This requirement includes equipment, modules, assemblies, parts, and components.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Refer to section 270000.

B. Coordinate layout and installation of equipment with owner’s communications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.

1.6 PROJECT/SITE CONDITIONS

A. Refer to section 270000.

1.7 WARRANTY

A. Refer to section 270000.

B. At the start of the project, contractor shall register the project with the manufacturer to help insure and facilitate manufacturer’s warranty process.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Horizontal Runway and Support Components

1. CPI 12 inch ladder rack black 10 foot section 10250-712

2. Owner approved alternate

B. Horizontal Rack-Mount Cable Management

1. CPI wall angle brackets black 11421-712

2. CPI T-junction splice kits 11302-001

3. CPI Vertical wall brackets 10608-001

4. Hilti 3/8” Screw Anchor KH 434436

5. CPI top plates black 10595-712

6. Owner approved alternate

C. Labeling

1. Refer to section 270000.
D. Firestopping
   1. Refer to section 270000.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Refer to Section 270000.

3.2 PREPARATION
   A. Refer to section 270000.
   B. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
   C. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.
   D. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.3 INSTALLATION
   A. Refer to section 270000.

3.4 FIELD QUALITY CONTROL
   A. Refer to section 270000.

3.5 CLEANING
   A. Refer to section 270000.

3.6 ACCEPTANCE
   A. Refer to section 270000.

END OF SECTION 271100
SECTION 27 1500

COMMUNICATIONS HORIZONTAL CABLEING

PART 1 - GENERAL

1.1 SUMMARY

A. This section of the horizontal cabling portion of a structured cabling system includes:
   1. UTP Copper cabling
   2. Termination and patch cables

B. Provide all horizontal cabling, terminating hardware, adapters, and cross-connecting hardware necessary to interconnect all system equipment including equipment located in communications rooms.

C. Related Sections
   1. Section 260000 Electrical (including related sub-sections)
   2. Section 270000 Communications
   3. Section 270526 Grounding and Bonding for Communications Systems
   4. Section 270528 Pathways for Communications
   5. Section 271100 Communications Equipment Room Fittings
   6. Section 271300 Communications Backbone Cabling
   7. Section 274100 Audio-Visual Systems
   8. Section 280000 Electronic Security (including related sub-sections)

1.2 REFERENCES

A. The publications listed below form a part of this specification. The publications are referred to in the text by basic designation only.

B. Specific reference in specifications to codes, rules, regulations, standards, manufacturer’s instructions, or requirements of regulatory agencies shall mean the latest printed edition of each in effect at the date of contract unless the document is shown dated.

C. Conflicts
   1. Refer to section 270000.

D. Codes and Standards
   1. Refer to section 270000.

1.3 SUBMITTALS

A. Refer to sections 270000 and 271300.
1.4 QUALITY ASSURANCE
   A. Refer to section 270000.

1.5 DELIVERY, STORAGE, AND HANDLING
   A. Refer to sections 270000 and 271300.
   B. Storage temperature range: -40°F to 149°F (-40°C to 65°C)

1.6 PROJECT/SITE CONDITIONS
   A. Refer to section 270000.

1.7 WARRANTY
   A. Refer to section 270000.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS
   A. Labeling
      1. Refer to section 270000.
   B. Firestopping
      1. Refer to section 270000.

2.2 ACCEPTABLE COPPER MANUFACTURERS
   A. UTP Plenum Rated Cable
      1. Systimax 2071E GigaSpeed XL7 White Plenum Cable We tote 700208101
      2. Systimax 2071E GigaSpeed XL7 Blue Plenum Cable We tote 700208093
      3. Owner approved alternate
   B. Data/Voice Outlet Components
      1. Systimax MGS400 GigaSpeed White Jacks (Voice) 700206725
      2. Systimax MGS400 GigaSpeed Blue Jacks (Data) 700206758
      3. Systimax 2-port Surface mount biscuit box 107984056
      4. Owner approved alternate
   C. Patch Panels (48 port)
1. Systimax GigaSpeed 48-Port PatchMax Panel 700176743
2. Owner approved alternate

D. Copper Patch Cords

1. Systimax
2. Owner approved alternate

2.3 ACCESSORIES

A. Mount one laminated full-size hard copy in color of an as-built floor plan designating workstation locations, pathways, and communications room locations. Confirm hard copy size with Owner.

B. Provide clear plastic lamination serving each communication room.

C. Install the laminated drawings within a protective Plexiglas encasement on the wall of the servicing communications rooms. To ease accessibility the Plexiglas encasement shall be in either flip-down format or file folder format.

2.4 HORIZONTAL COPPER CABLING

A. Recognized cabling for providing the signal medium from the work area to the communications room shall include the following:

1. Category 6 UTP cable
2. 

B. Category 6 UTP Cable Requirements

1. 23/24 AWG solid bare copper
2. Cable jacket shall comply with NEC Article 800 for use as a plenum cable and shall be UL and c (UL) Listed Type CMP (communications multipurpose plenum)
3. Cable shall terminate on an eight-pin modular jack at each outlet. All horizontal cabling shall meet or exceed the ANSI/TIA-568.2-D Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted Pair Cabling Components
4. Cables shall be marked as UL verified with a minimum of Category 6 rating
5. The cable shall support Voice, Analog Base band Video/Audio, Fax, Modem, Switched-56, T-1, ISDN, RS-232, RS-422, RS-485, 10BASE-T Ethernet, Token Ring, 100Mbps TP-PMD, 100BASE-T Ethernet, 155 Mbps ATM, AES/EBU Digital Audio, 270 Mbps Digital Video, 622 Mbps 64-CAP ATM and emerging high-bandwidth applications, including 1 Gbps Ethernet, gigabit ATM, as well as all 77 channels (550 Mhz) of analog broadband video
6. The maximum horizontal cable length for Category 6 copper cable from the termination of the cable in the communications room to the outlet is 295'-0".
7. Cable shall meet or exceed the following electrical characteristics:
8. Cable shall be specified to 250 MHz and shall meet the manufacturer’s guaranteed electrical performance and physical specifications.

2.5 TERMINATION HARDWARE

A. Patch panels
1. Patch panels shall be rated to match installed cable plant
2. The wiring block shall accommodate #23 AWG cable conductors.
3. All modular cross connect panels shall be UL-listed.

B. Work Area Outlet

1. Universal eight-position jack pin/pair assignments
2. Jack Color:
   a) Data: Green
   b) Voice: White
   c) Security: Orange
   d) Wireless: Yellow

C. Work Area Outlet Faceplates:

1. White or ivory to match electrical outlets.

2.6 PATCH CABLES

A. Verify exact quantities and lengths with Owner prior to purchase

B. Patch Cable requirements:

1. Panduit Category 6 Patch Cord (Green) 5ft UTP28SP5GRY
2. Panduit Category 6 Patch Cords (Green) 14ft UTPSP14GRY
3. Panduit Category 6 Plenum Cable Blue PUP6004BU-W
4. Panduit Category 6 TX-6 Module (Yellow) CJ688TGYL

C. Provide either a 5'-0" or 14'-0" Patch Cords at the communications room for each installed port.

1. Coordinate with Owner on the active equipment layout prior to purchase to ensure correct sizing of patch cords from patch panels to switching equipment.
2. The voice patch cords will be patched over in each communication room by Vendor from the station rack voice jack to the voice rack to patch panels or with-in a rack. The # of white patch cords you patch over will be determined by how many voice cables are in the station rack. You will then provide a cut sheet that shows what voice station # goes to what port on the voice patch panel and then what tie pair. back down to the MDF and what tie pair on the feeder cable back to MDF IT room 1A. All voice cables will be patched over in each IDF back to the MDF. Example IT room 2A-49 port of Station Rack patched to 2 port of Voice Rack-jumper wired to 1st pair of feeder cable
3. In each voice rack in each IT room a 1-pair Avaya jumper wire will be installed from 110 rack mounted block C-5 clip to the 110 rack mounted block C-4 clip white/blue position. As many voice cables as you have in the station rack in each communication room will determine how many jumpers are installed and how many ports and patch panels are needed in the Voice Rack. The power point pic shows 192 ports. This is maximum now since we typically do VOIP less ports are needed. Again as many voice cables plus some future growth for this Voice Rack. Each port of the top patch panels get 4 pair per port. The 2nd and 3rd pair are reversed. Example 1st port-wb/bl wg/ow wbr/brw
4. Data and Security Cameras will have 2-CAT 6 patch cords-1 14ft. at communication outlet and 1 5ft. for IT room. For classrooms with less than 100 seats, WAP’s will have 1 CAT 6 patch cord 5’ for IT room, 14 ft. at WAP. For classrooms with 100 seats or larger, WAP’s will have 2 CAT 6 patch cords 5’ for IT room, 14ft. at WAP. These patch cords all match
the color of the jacks. See BOM below for all part numbers. All horizontal cable is blue except when cable needs to be exposed—we will let UNT System choose the color that fits these areas. All cable CAT 6 except WAP and RED inter-closet cables CAT 6. Color of Faceplates will match electrical outlets.

5. When connecting voice ports to a copper riser, provide a one-pair stranded 8P8C connector on one end and 110GS on the other end and shall be of appropriate length for application.

D. Provide a 10'-0" Station Cord for each work area outlet port.

E. Place each size/length patch cord in a separate container, and mark the containers that hold the patch cords with the length of patch cords contained within.

F. All cords shall conform to the requirements of ANSI/TIA-568.2-D Commercial Building Telecommunications Cabling Standard, Horizontal Cabling Section, and be part of the UL LAN Certification and Follow-up Program.

G. Cords shall be equipped with an eight-pin modular connector on each end, wired straight through and shall be of appropriate length for application.

H. All rated patch cords shall be round, and consist of #23 AWG copper, stranded conductors, tightly twisted into individual pairs.

I. Patch cords shall be made and warranted by the manufacturer of the cabling system installed in this project and shall meet or exceed patch cord specifications as outlined in TIA standards.

2.7 IDENTIFICATION (LABELING) SYSTEM

A. Refer to sections 270000 and 271300.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Refer to Section 270000 and 271300.

3.2 PREPARATION

A. Refer to section 270000.

B. The Contractor shall check pathways, raceways, and other elements for compliance with space allocations, installation tolerances, debris, hazards to cable installation, and other conditions affecting installation prior to installation.

3.3 INSTALLATION REQUIREMENTS

A. Refer to section 270000.
B. All installation shall be done in conformance with ANSI/TIA-568-D standards, BICSI methods, industry standards and manufacturer's installation guidelines.
   1. The Contractor shall ensure that the maximum pulling tensions of the specified distribution cables are not exceeded and cable bends maintain the proper radius during the placement of the facilities.
   2. Failure to follow the appropriate guidelines shall require the Contractor to provide in a timely fashion the additional material and labor necessary to properly rectify the situation.
   3. This shall also apply to any and all damages sustained to the cables by the Contractor during the implementation.

C. Install cable using techniques, practices, and methods that are consistent with specified data cabling and the installed components and that ensure specified performance levels of completed and linked signal paths, end to end.
   1. Pull cables in smooth and regular motions using methods that prevent cable kinking.
   2. Pull cables simultaneously if more than one is being installed in the same raceway/pathway.
   3. If necessary, use approved cable pulling lubricant
   4. Use fish tape, cable, rope, basket weave wire/cable grips, and other tools that will ensure no damage to the media or raceway.
   5. Install open cabling parallel and perpendicular to surfaces or structural members following surface contours where possible.
   6. Do not bend cable greater than a bend radius of 0'-1".

D. Provide a 10'-0" service loop at the communications room and shall provide a 3'-0" service loop above the access ceiling or cable trays unless specified otherwise.
   1. All service loops shall be a minimum of 1'-6" (18") in diameter and be accessible for maintenance.

E. Coordinate loop placement and orientation with the technology consultant.
   1. This allows for future changes or expansion without installing new cables.

F. Install cables in continuous "home run" lengths from work station outlet to specified patch panel.
   1. No intermediate punch down blocks or splices may be installed or utilized between the communications rooms and the workstation outlet without written Owner permission.

G. All cable must be handled with care during installation so as not to change performance specifications.
   1. Factory twists of each individual pair must be maintained up to the connection points at both ends of the cable.
   2. There shall never be more than 0'-½" of unsheathed cable at either the wiring closet or the workstation termination locations.

H. All cabling and associated hardware shall be placed so as to make efficient use of available space.
   1. All cabling and associated hardware shall be placed so as not to impair equipment's efficient use of their full capacity.
3.4 CABLELING METHODS

A. The Contractor shall provide cabling in accessible spaces, cable tray, (surface and/or enclosed raceway), conduits, and/or J-Hook cable support system.

1. Within consoles, racks, cabinets, desks, and counters, in accessible ceilings spaces and in gypsum board partitions where open cable method may be used.
2. Use UL or ETL listed plenum rated cable in all spaces.
3. Provide all necessary installation materials, hardware, tools and equipment to perform insulation displacement type terminations at all data outlets, patch panels, and voice termination materials.

B. Conceal raceway and cabling except in unfinished spaces as is practical.

C. Exposed Cable

1. All station cabling shall be installed inside walls or ceiling spaces whenever possible.
2. Exposed station cable will only be run where indicated on the drawings and will only be allowed when no other options exist.
   a) Owner must approve all exceptions.

D. The Contractor shall utilize conduits/cable tray as indicated on the drawings.

E. All cabling placed above drop ceilings must be supported by cable tray, J-hooks, caddy bags or conduit.

1. The Contractor shall permanently affix cable supports to the building structure or substrates and provide attachment hardware and anchors designed for the structure to which attached and are suitably sized to sustain the weight of the cables to be supported.
   a) Attaching cable to pipes or other mechanical items is not permitted.
   b) Cabling shall not be attached to ceiling grid wires.
2. Multiple cables are to be dressed every 5'-0" to 7'-0".
   a) Maximum cable sag between cable hooks is 3"-6".

F. The Contractor shall route data and voice cables separately in a neat and orderly fashion.

1. No cable ties or wraps shall be used to secure the cables in the runway outside of the communications rooms. Cable ties shall be rated for the environment.

G. Keep all items protected before and after installation with dust and moisture proof barrier materials/envelopes.

H. If wiring is terminated on patch panels, data, voice jacks prior to painting, carpet installation, and general finish clean up, these jacks shall be placed in a protective envelope to ensure dust, debris, moisture, and other foreign material do not settle onto jacks’ contacts.

1. Envelope will be removed on final trim out after other trades have completed their finish work.
2. It shall be the Contractor’s responsibility to ensure the integrity of these protective measures throughout the life/installation of the project.
a) Cable bundles brought into the communications rooms shall be routed and dressed in such a manner that prior to termination the cables are not subject to damage and misuse such as installers walking on the bundles that are on the floor.

b) Cable pulling force shall not exceed 25 lbs of pulling tension or cable manufacturer’s recommended pulling tensions.

c) Do not leave cables on the floor unprotected or cable bundles hanging from the ceilings. Coil them up in a temporary manner and protect them from damage.

I. Communications room cables shall be combed and dressed in a manner as to prevent twists, “braiding” and crossed cables in the cable bundle from the communication room entrance to the termination point at the rear of the patch panel.

1. Behind the patch panel, the cable bundle shall be attached to the rear cable support bar, and shall drop out each cable in a neat, cascading manner to prevent crossed and/or interwoven cables to each patch panel port termination point.

   a) Use Velcro wraps instead of cables ties for all bundling in the communications rooms.

   b) Plastic/nylon tie-wraps are not allowed to permanently secure cables inside the communications room.

3.5 CABLING SEPARATION

A. Comply with TIA rules for separating unshielded copper communication and data-processing equipment cables from potential EMI sources, including electrical power lines and equipment.

B. Maintain a minimum spacing of 1'-6" (18") from electrical feeders and/or branch circuit wiring including, but not limited to, light fixtures, sources of heat and EMI sources.

C. Maintain a minimum spacing of 1'-0" from auxiliary systems cabling.

D. Maintain a 1'-0" separation where cables must pass perpendicularly to electrical, plumbing, or other wiring, conduit, or piping systems.

   1. Use non-conduit bushings, if necessary to maintain separation, which allow for the addition of a reasonable number of cables in the future.

E. Maintain communications pathways away from electrical apparatus such as motor driven equipment and transformers, minimum separation distance of 10'-0" is recommended.

3.6 CABLING TERMINATION

A. Terminate cables in consistent consecutive order.

B. Terminate cables onto 8P8C modular patch panels without damaging twisted pairs or jacket.

C. Arrange cables on patch panels and voice termination hardware in ascending order of room numbers and outlet numbers within rooms.

D. Provide a 10'-0" service loop for horizontal cables at each rack in communications rooms.

   1. Locate loop at ceiling deck or on bottom of cable runway in minimum 1'-6" (18") diameter.
E. Provide a 3’-6” service loop for horizontal cables at work area outlets. Locate service loop above or below data/voice outlet were vertical cable run transitions to horizontal run.

F. Maintain twists in cable pairs to within 0’-½” of termination.

G. Video Surveillance Systems Cabling (Electronic Safety and Security <ESS> devices)
   1. Video Cameras will require a field terminated plug on the end of a horizontal cable to be directly plugged into device.
      a) Follow TIA-862-B Building Automation Standard.
      b) Contractor shall use applicable equipment in testing solid conductor plug.
   2. Group all security systems cables in one group.
   3. Clearly label cable number and function, in the last positions on the horizontal cabling blocks in each communications room.

H. Building Systems Cabling (BAS, FA, elevator line, etc)
   1. Coordinate exact placement and connectivity requirements with applicable trade prior to installation.
   2. Group all building systems cables in one group.
   3. Clearly label cable number and function, in the last positions on the horizontal cabling blocks in each communications room.

I. Limit cable-bending radius to 20X the cable diameter during installation, and 15X the cable diameter after installation.

J. Start numbering at the left of the main door to the room and continue in a clockwise direction around the room.
   1. The cables within the room will be terminated starting with the cables located to the left of the main door to the room and continue around the room in a clockwise direction.

3.7 TERMINATION HARDWARE

A. Station Hardware
   1. Flush mount jacks shall be mounted in a faceplate with back box.
   2. Outlets shall not be mounted on temporary, movable, or removable surfaces, doors, or access hatches without prior Owner approval.
   3. 8P8C Jack Pin Assignments for work area outlets shall match the T-568A wiring scheme.

B. Patch panels
   1. Copper cables shall be terminated in eight position/eight conductor (8P8C) modular patch panels.
   2. All Modular jack panels shall match the T-568A wiring scheme.

C. Work Area Outlet
   1. 8P8C non-keyed modular outlets for applications up to one Gbps and ANSI/TIA-568-D compliant for the specified transmission requirements.
D. Work Area Outlet Faceplates:
   1. Furnish and install blank plates in all unused ports.

3.8 SPECIAL CIRCUITS

A. The Contractor shall coordinate with the Owner on the cable termination plan for special circuits, including cables to wireless access point locations, security, elevators, fire alarms, etc.

B. Wireless Access Points
   1. Install two (2) cable(s) from dedicated wireless patch panel(s) in communications room to outlets having 8P8C connectors within a secure metal enclosure.
   2. Enclosures shall be NEMA rated for the environment to which they are exposed.

3.9 IDENTIFICATION AND LABELING

A. Labeling system shall consist of a hand-held portable printer and labels appropriate to the application. Handwritten labels are not acceptable.

B. Fiber termination hardware (designation strip) shall have a 0'-¾" x 0'-¼" thermal transfer printable label with a permanent acrylic adhesive.

C. 110-type copper termination hardware shall have a laser printable, non-adhesive label designed for 110 terminal block marking.

D. All WAP's will be labeled at the biscuit jack and on the WAP. If mounted above drop ceiling a black label with white lettering will be installed on the grid wire.

E. All labels shall be permanent and shall not fade, peel, or deteriorate due to environment or time.

F. The Contractor shall provide a copy of the finalized plan in writing to the Owner representative and DataCom Design Group for review and authorization to proceed.
   1. Coordinate with Owner for specifications on labeling of all hardware, cabling, and related equipment prior to any testing.

G. Labeling requirements:
   1. Label cable terminations on designation strips.
   2. Label all cable at each terminating point.
   3. Label each port of the work area outlet.
   4. Cable identification numbers shall not be duplicated.
   5. Label patch panels and wall mounted termination blocks in the communications rooms to match those on the corresponding voice and data outlets.
      a) The font shall be at least 0'-1/8" in height.
   6. Where a wireless access point is installed above an acoustical ceiling, label the ceiling grid frame below the access point, displaying the data port number and, if applicable, the access point identification number. Coordinate labeling of grid with Owner and Architect prior to application of labels.
7. Label each distribution rack, block and other terminating equipment unit and field within that unit within 0'-4" from the block or patch panel termination. Keep labels in a neat and orderly lineup.

8. Label each connector and each discrete unit of cable-terminating and connecting hardware within connector fields, in wiring closets and equipment rooms.
   a) Where similar jacks and plugs are used for both communication and data-processing equipment, use a different color for jacks and plugs of each service.

9. Post the cable schedule in a prominent location in each wiring closet and equipment room. List incoming and outgoing cables and their designations, origins, and destinations.

H. Location and termination field description
   1. Room location
   2. Rack-mount or Wall mount
   3. Termination field type
      a) Specific patch panel ports versus a separate dedicated patch panel
      b) 110-type or M66 blocks

I. Unique identifiers
   1. Segregation and position on equipment rack
   2. Port color-coding
   3. Unique labeling

J. Documentation
   1. Provide electronic copy of final comprehensive schedules for project in software and format selected by Owner.
      a) All labels shall correspond to as-built drawings and to final test reports.
   2. All cable inventory data documentation shall be submitted in format coordinated with and approved by Owner so that data can be incorporated into existing databases.
   3. Documentation shall include cable identification number, source and destination, type of cable, length of cable and number of pairs or fibers.
   4. Complete cross connect documentation is required.

3.10 FIELD QUALITY CONTROL
   A. Refer to section 270000.

3.11 POST-INSTALLATION TESTING
   A. Contractor shall test each pair or strand of every cable prior to acceptance. (100% PASS)
   B. Contractor shall submit acceptance documentation as defined below. No cabling installation is considered complete until test results have been completed, submitted and approved.
   C. Standards Compliance and Test Requirements:
1. Cabling shall meet ANSI/TIA-568.2-D Category 6 Horizontal cabling requirements.

D. Attenuation, NEXT, PSNEXT, Return Loss, ELFEXT, and PSELFEXT data that indicate the worst case result, the frequency at which it occurs, the limit at that point, and the margin.

   1. These tests shall be performed in a swept frequency manner from 1 MHz to highest relevant frequency, using a swept frequency interval that is consistent with TIA and ISO requirements.
   2. Information shall be provided for all pairs or pair combinations and in both directions when required by the appropriate standards.
   3. Length, propagation delay, and delay skew relative to the relevant limit.
      a) Length, propagation delay, and delay skew shall be tested relative to the relevant limit.
      b) Test shall also include mutual capacitance and characteristic impedance.
         1) Any individual test that fails the relevant performance specification shall be marked as a 'FAIL'.

E. Cable Test Documentation:

   1. Cable test documentation shall be submitted in hard copy and electronic formats.
      a) If proprietary software is used, disk or CD shall contain any necessary software application required to view test results.
      b) Electronic reports shall be accompanied by a Certificate signed by an authorized representative of the Contractor warranting the truth and accuracy of the electronic report.
      c) Certificate shall reference traceable circuit numbers that match the electronic record.

   2. Each test record shall contain the cable ID as follows:
      a) “MEDIA TYPE – SOURCE ROOM – DESTINATION ROOM – STRAND/PAIR #”, e.g. MM-MC-HC23-001.

   3. Test results saved within the field-test instrument shall be transferred into an accessible database utility that allows for the maintenance, inspection and archiving of the test records.
      a) These test records shall be uploaded to the PC unaltered, i.e., “as saved in the field-test instrument”.
      b) The file format, CSV (comma separated value), does not provide adequate protection of these records and shall not be used.

   4. Test reports shall include the following information for each cabling element:
      a) Wire map results that indicate that 100% of the cabling has been tested for shorts, opens, miss-wires, splits, polarity reversals, transpositions, presence of AC voltage and end-to-end connectivity.
      b) Length, propagation delay, and delay skew relative to the relevant limit. Any individual test that fails the relevant performance specification shall be marked as a FAIL.
      c) Cable manufacturer, cable model number/type, and NVP
      d) Tester make & model, serial number, hardware version, and software version.
e) Cable ID and project name  
f) Auto-test specification used  
g) Overall pass/fail indication  
h) Date of test

F. Cable Test Equipment

1. Contractor shall supply all of the required test equipment used to conduct acceptance tests.  
2. Test equipment used under this contract shall be from manufacturers that have a minimum of 5 years experience in producing field test equipment. Manufacturers shall be ISO 9001 certified.  
3. Testing equipment shall be UL-verified to meet Level III accuracy.  
   a) The cable installers shall have a copy of this reference in their possession and be familiar with the contents.
4. Testing equipment shall be within the calibration period recommended by the manufacturer.  
5. Testing equipment shall have the latest software and firmware installed.  
6. Testing equipment of a given type shall be from the same manufacturer, and have compatible electronic results output.  
7. Test adapter cables shall be approved by the manufacturer of the test equipment.  
   a) Adapter cables from other sources are not acceptable.  
   b) Adapter cables must be replaced after 1000 tests to ensure accuracy.
8. Test equipment must have a dynamic range of at least 100 dB to minimize measurement uncertainty.  
9. Test equipment must be capable of storing full frequency sweep data for all tests and printing color graphical reports for all swept measurements.  
10. Test equipment must include S-Band time domain diagnostics for NEXT and return loss (TDNXT and TDRL) for accurate and efficient troubleshooting.  
11. Test equipment must be capable of running individual NEXT, return loss, etc measurements in addition to auto tests. Individual tests increase productivity when diagnosing faults.  
12. Test equipment must include a library of cable types, sorted by major manufacturer.  
13. Test equipment must be able to internally group auto tests and cables in project folders for good records management.  
   a) Test equipment must store at least 1000 auto tests in internal memory.
14. Test equipment must include DSP technology for support of advanced measurements.  
15. Test equipment must make swept frequency measurements in compliance with TIA standards.  
16. The measurement reference plane of the test equipment shall start immediately at the output of the test equipment interface connector.  
17. There shall not be a time domain dead zone of any distance that excludes any part of the link from the measurement.  
18. Acceptable testers:  
   a) Fluke DTX CableAnalyzer  
   b) Owner approved equivalent

3.12 FIBER TESTING
3.13 CLEANING

A. Refer to section 270000.

3.14 ACCEPTANCE

A. Once all work has been completed, test documentation has been submitted and approved, and the Owner is satisfied that all work has been completed in accordance with contract documents, the Owner will notify Contractor in writing of formal acceptance of the system.

B. Contractor's RCDD shall warrant in writing that 100% of the installation meets the requirements specified herein.

C. Acceptance shall be subject to completion of all work, successful post-installation testing which yields 100% PASS rating, and submittal and approval of full documentation as described above. Tests with the "* PASS" (asterisk) will not be acceptable.

1. These circuits must be repaired to meet “PASS”.

END OF SECTION 271500
1.1 SECTION 27 4113

ARCHITECTURALLY INTEGRATED
AUDIO VIDEO INFRASTRUCTURE

PART 2 GENERAL

2.1 CONDITIONS AND REQUIREMENTS

A. The General Conditions, Supplementary Conditions, and Division01 – General Requirements apply.

2.2 SECTION INCLUDES

A. Floor Boxes
B. Poke-Thru Devices
C. Flat Panel Display In-Wall Storage Boxes
D. Wall Junction Boxes
E. Pull Boxes
F. Plenum Ceiling Boxes
G. Projection Screens

2.3 RELATED SECTIONS

A. Division 09 – Flooring Systems
B. Division 26 – Electrical, Electrical Systems and Components
C. Division 27 – Communications: Communications Systems and Components
D. Division 28 – Electronic Safety and Security: Security Systems and Components

2.4 SUBMITTALS

A. Comply with requirements of Secton 01 22 00 – Submittal Procedures

1. Product Data: For the following Infrastructure System components
   a) Poke-Thru Devices
   b) Flat Panel Display In-Wall Storage Boxes
   c) Wall Junction Boxes
   d) Pull Boxes
   e) Plenum Ceiling Boxes
   f) Product Data Binders

2. Product Data: For the following Infrastructure System components
   a) Poke-Thru Devices
   b) Flat Panel Display In-Wall Storage Boxes
   c) Wall Junction Boxes
   d) Pull Boxes
   e) Plenum Ceiling Boxes
   f) Product Data Binders

2.5 QUALITY ASSURANCE

A. General

1. Floor Boxes provide the interface between power, audio video (A/V), and communications cabling in concrete floors and decks at activation locations requiring power, audio-video, or communication device outlets.
   a) ADA Compliance: Flush-mounted floor device outlets shall not create tripping hazard.

2. Poke-thru devices provide the interface between power, communication and audio-video (A/V) cabling in an above grade concrete floor and the activation location where power communication and/or A/V device outlets are required. These poke-thru devices provide recessed device outlets that will not obstruct the floor area.
a) ADA Compliance: Flush-mounted floor device outlets shall not create tripping hazard.

3. Flat Panel Display In-Wall Storage Boxes provide the interface between power, audio-video (A/V), and communications cabling in recessed cavity of wall behind flat panel displays where power, communication and/or A/V device outlets and/or device storage/mounting is required.

4. Wall Outlet Boxes provide the interface between power, audio-video (A/V) and communications cabling in walls at activation locations requiring power, audio-video, or communication device outlets.

5. Pull and Junction boxes provide an accessible pathway in a run of conduit to facilitate the pulling in of wires and cables.

B. Manufacturer Qualifications: Firms regularly engaged in manufacture of floor boxes, poke-thru devices and in-wall storage boxes of the types and sizes required, whose products have been in satisfactory use in similar service for not less than 10 years. Provide floor boxes, poke-thru devices, in-wall storage boxes, electrical junction boxes, pull boxes and plenum ceiling boxes that are produced by a manufacturer listed in this section.

C. Electrical Raceways and Components: Comply with requirements of applicable local codes, NEC, UL, and NEMA Standards pertaining to raceways and components. Listed and labeled in accordance with NFPA 70, Article 100.

2.6 DELIVERY, STORAGE AND HANDLING

A. Deliver floor boxes, poke-thru devices, and in-wall storage boxes and associated fittings in factory labeled packages.

B. Store and handle in strict compliance with manufacturer’s written instructions and recommendations.

C. Protect from damage due to weather, excessive temperature, and construction operations.

PART 3 PRODUCTS

3.1 GUIDELINES

A. Floor Boxes, Poke-thru Devices, Wall Junction Boxes and Pull & Junction Boxes shall be furnished and installed by the Electrical Contractor selected by the Owner unless specifically excluded in these specifications or drawings.

1. Coordinate with AV Contractor regarding proper placement of duplex outlets for any AV designated floor box or Poke-thru Device. Electrical circuits should be connected (and outlets wired) to the designated AV circuit breaker panel (N.I.C.). Ensure that “Star” ground configuration is properly implemented. Ensure that ground wires from each outlet are isolated from conduit, neutrals, and each other.

B. In-Wall Storage Boxes and Plenum Ceiling Boxes shall be furnished, and installed by the Electrical Contractor unless specifically excluded in these specifications or drawings.

1. Coordinate with AV Contractor regarding proper placement of duplex outlets for any AV designated Plenum Ceiling Box and/or In-Wall Storage Box.

C. Floor Box Inserts/Plate and Poke-thru Device Inserts/Plates shall be furnished and installed by the AV Contractor selected by the Owner unless specifically excluded in these specifications or drawings.

D. Condition - Provide and install products listed in this section in factory new condition, conforming to applicable provisions of American National Standards Institute.

3.2 ACCEPTABLE MANUFACTURERS

A. Substitutions will be considered under provisions of Section 01 25 00.

B. The following are major infrastructure products for this project.
1. AVP TYPE 1 (Audio Video Plate)
   a) Raco Model 260 Electrical Junction Boxes shall be 3-1/4" deep, 4-11/16" square with (2) 1/2"-3/4", (2) 3/4"-1" and (2) 1-1/4" side knockouts and (2) 1/2" & (2) 3/4"-1" bottom knockouts. Box shall be provided with Raco 818 two gang device cover.

2. FPD TYPE 1 (Flat Panel Pull Box)
   a) Chief Manufacturing PAC526FW in-wall pull box

3. PT TYPE 1 (Poke Thru)
   a) Type 1 Wiremold Evolution 8AT Series Poke-Through (Small conference)
   b) Type 2 Wiremold Evolution 10AT Series Poke-Through (Classrooms)
   c) Include top and bottom plates
   d) Cover finish per Architect
   e) Provide the following interior mounting plates:
      1) Two (2) 68REC
      2) One (1) 8ACT6A
      3) One (1) 8AAP
      4) One (1) 8CREST
   f) Provide the following bottom feed device plates:
      1) Three (3) 1125CHA
      2) One (1) 575CHA
      3) Provide 8DIV Divider plate

4. FRK TYPE 1 (Equipment Rack)
   a) HOFFMAN ASE8x9x3 8” x 9” x 3” NEMA 1 pull box. Box shall be provided with screw cover.

PART 4 EXECUTION

4.1 EXAMINATION
   A. Examine conditions under which boxes, poke-thrus’ fittings, and projection screens are to be installed and substrate that will support boxes. Notify the Architect in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.
      1. Do not begin installation until substrates have been properly prepared.
      2. Verify rough-in openings are properly prepared.

4.2 DOCUMENT INTERPRETATION
   A. The locations of the outlet symbols shown in the Drawings represent a close approximation of the exact location where the outlet shall be installed. This location may be shifted left or right eight inches to allow for stud alignment or coordination with electrical outlet locations. Approval by Owner is required for more extensive adjustments to outlet location.
   B. Outlet Schedule
      1. Refer to the outlet schedule contained [on the Drawings sheet XXX] for outlet mounting height, device box size, and station conduit size.

4.3 PREPARATION
   A. Clean surfaces thoroughly prior to installation.
   B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

4.4 INSTALLATION
A. Strictly comply with manufacturer’s installation instructions and recommendations and approved shop drawings. Coordinate installation with adjacent work to ensure proper clearances and to prevent electrical hazards.

B. Mechanical Security: Raceway systems shall be mechanically continuous and connected to all electrical outlets, boxes, device mounting brackets, and cabinets, in accordance with manufacturer’s installation sheets.

C. Accessories: Provide accessories as required for a complete installation, including insulated bushings and inserts where required by manufacturer.

D. Unused Openings: Close unused box openings using manufacturers recommended accessories.

E. Provide a minimum concrete pour depth of 3-7/16-inch [87mm] plus 1/16-inch [1.6mm] above the top of the box for the RFB4, RFB4-4DB, RFB2, and the RFB2-OG Series Boxes; 2-7/16-inch [62mm] plus 1/16-inch [1.6mm] for the RFB4-SS and RFB2-SS Series Boxes; and 3-7/16-inch [87mm] plus 13/16-inch [21mm] above the top of the box for the RFB4-CI-1, RFB6, and RFB6-OG Series Boxes; and 4-1/16-inch [103mm] above the top of the RFB4E and RFB4E-OG Series Boxes; and 4-inch [102mm] above the top of the RFB6E and RFB6E-OG Series Boxes. Provide the box with four (4) locations to accommodate leveling for pre-concrete pour adjustment and include four (4) leveling screws for the pre-pour adjustment.

F. The 6AT, and 6ATCFF units shall mount in a 6" [152mm] cored hole, actual 6 1/16" [154mm] core hole. The 8AT units shall mount in an 8" [203mm] cored hole, actual 8 1/16" [205mm] core hole. Use is defined by the UL Fire Resistance Directory as a minimum spacing of “2 ft. [610mm] on center and not more than one device per each 65 sq. ft. [6m²] of floor area in each span”.
   1. Installation shall be completed by pushing unit down into the cored hole. Prior to and during installation, refer to system layout and/or approval drawings. Installer shall comply with detailed manufacturer’s instruction sheet included with each device. The unit shall contain a retainer for securing the device in the slab, as well as the necessary intumescent material to seal the cored hole under fire conditions.

G. Outlet Box Mounting:
   1. Station cable boxes shall be 4-11/16" square x 3" deep regardless of cable count or cable type.
   2. Height: unless otherwise noted in the Outlet Schedule, all communication outlet boxes shall be installed at the same height as electrical outlets, except WCP outlets, which shall be installed at 48 inches AFF to center of box.
   3. Install boxes to accommodate device indicated by symbol, in conformance with code requirements and consistent with type of construction.
   4. Install the appropriate work cover on all outlet boxes.
   5. Set front edge of device box flush with the finished surfaces except on walls of noncombustible materials where the boxes may have maximum set back of ¼”. Secure flush-mounted box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
   6. Set outlet boxes parallel to construction and independently attached to same.
   7. Do not install back-to-back and through-the-wall boxes. Install with a minimum 6” horizontal separation between closest edges of the boxes. Install with minimum 24” separation in acoustic rated walls.
   8. Outlet boxes for audiovisual shall be in a separate box from electrical outlets.

H. Box Support:
   1. Mount boxes straight and plumb.
   2. Install stud support one side, with short piece of stud, for up to 2-Gang device boxes.
   3. Do not support boxes with tie-wire.
   4. For one- and two-gang box support, manufactured bracket supports shall be accepted alternate.
   5. Support boxes independently of raceways.
6. Install adjustable steel channel fasteners for hung ceiling outlet boxes.
7. Install stamped steel bridges to fasten flush-mounted junction box between studs.
8. Do not install boxes to ceiling support wires or other piping systems.
9. When boxes are installed in fire-resistive walls and partitions, provide 24" horizontal separation between boxes on opposite sides of a wall. In addition, limit penetrations to 16 square inches per penetration and not to exceed a total of 100 square inches per 100 square feet of wall area. Apply fire stop putty or muffins acceptable to the authority having jurisdiction (AHJ).

I. **Projection Screen Installation**

1. Install in accordance with manufacturer’s instructions.
2. Install front projection screens with screen cases in position and relationship to adjoining construction as indicated, securely anchored to supporting substrate, and in manner that produces a smoothly operating screen with plumb and straight vertical edges and plumb and flat viewing surfaces when screen is lowered.
3. Test electrically operated units to verify that screen, controls, limit switches, closure and other operating components are in optimum functioning condition.

4.5 **CLEANING AND PROTECTION**

A. Clean exposed surfaces using non-abrasive materials and methods recommended by manufacturer.
B. Protect boxes and fittings until acceptance.

4.6 **STORAGE AND HANDLING**

A. Schedule delivery to minimize delays in the project.
B. Provide storage protection against temperature and humidity extremes, theft, vandalism, physical damage, and environmental damage.

END OF SECTION
1.1 SECTION 27 4116

PART 2 GENERAL

1.1 SUMMARY
A. This document covers the general requirements for the installation of audiovisual (AV) systems.

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

1.3 CODES
A. Execute work in accordance with best AV system installation practices, National Electrical Code, and applicable state and local codes.

1.4 REGULATIONS
A. Comply with terms and conditions of Americans with Disabilities Act, especially regarding provisions for hearing impaired and wheelchair access in control areas.

1.5 SUBMITTALS
A. General
1. Refer to Division 1.
2. Submit in quantities, format and timetable as required by General Conditions.

B. Product Data Binders
1. Minimum number of Sets: four (4).
2. Timetable
   a) Submit within thirty (30) days after award of contract.
   b) Submit simultaneously with Shop Drawings.
   c) Drawing must be reviewed, approved and stamped with either an AVIXA CTS-I or CTS-D certification from a staff member employed by the AV firm.
   d) Allow minimum of ten (10) business days for review. All sets minus one (1) will be returned with review comments. If a resubmit is required, resubmit total quantity of complete sets. If second resubmit is required, Contractor shall reimburse Owner for expenses incurred during additional review process.
   e) Review and approval of Product Data is required before equipment purchase and installation.
   f) Bind product data sheets together either in GBC or 3-ring type binders at owners request.

C. Shop Drawings
1. Minimum Number of Sets: four (4).
2. Timetable
   a) Submit within thirty (30) days after award of contract.
   b) Submit simultaneously with Product Data Binders.
   c) Allow minimum of ten (10) business days for review. All sets minus one (1) will be returned with review comments. If a resubmit is required, resubmit total quantity of complete sets. If second resubmit is required, Contract shall reimburse Owner for expenses incurred during additional review process.
   d) Number and title each drawing in logical manner as a set.
   e) Include cover sheet with listing of all drawings included in bound set.
f) Ensure that labeling on Shop Drawings match labeling on equipment.

g) Minimum Scale:
   1) Floor Plans: 1/8 inch = 1 foot.
   2) Rack Elevations: 1-1/2 inch = 1 foot.
   3) Plate/Panel Details: 6 inches = 1 foot.
   4) Loudspeaker Details: 1 inch = 1 foot.

h) Include as a minimum:
   1) Floor plans indicating locations of all AV devices, vertical risers, pull boxes, and exposed wiring. Include Device ID (FPD, MRK, PT, AVP, etc., as referenced in design contract documents), as appropriate for projectors, screens, racks, floor boxes, AV plates in walls, etc.
   2) Schematic diagram showing all primary and secondary devices, interconnectivity and signal flow.
   3) Plate details showing size, material, finish, connectors, engraving, etc.
   4) Mounting detail drawings of loudspeakers, racks, and overhead equipment.
   
   Hire services of professional structural engineer, licensed by the appropriate governing authority, to review shop drawings, building structural drawings, and any existing structures from which equipment is to be suspended. Include Structural Engineer’s stamped report with shop drawing submittal. Report shall include:

   i) Itemization of items reviewed by the Structural Engineer.
   
   j) Confirmation that proposed methods of suspending equipment as shown on the shop drawings conform to required safety factors.

   k) Confirmation that building structure from which equipment is to be suspended will support equipment including required safety factors.

   1) Rack elevations.
   2) Complete schematic diagram. One-line diagram with detailed descriptions of product inputs and outputs is acceptable. Include terminal strip details and cable label information. If wiring diagram spans more than three (3) sheets, additionally provide simplified block diagram of entire system on one (1) sheet.
   3) Electrical power wiring diagram. Include circuit, switching, and control details.
   4) Wiring diagram of grounding and shielding scheme.
   5) Drawings for custom-fabricated items (i.e., plates, panels, cables, and assemblies).
   6) General construction drawings necessary for completion of work.

D. Operation and Maintenance Manuals

   1. Minimum number of Sets: four (4).
   2. Bind Operation and Maintenance Manuals using either GBC or 3-ring binders.
   3. Format and Minimum Information below:

   a) Section 1 - System Operation.
      1) Introduction/overview to system components and their functions and locations. Include a brief listing of basic system functions.
      2) Complete but simple system operating instructions to accomplish basic system functions, written for non-technical personnel.
      3) Certificate indicating names of Owner personnel trained by AV Contactor, date of training, name of AV Contractor representative that provided training, and name of project.

   b) Section 2 - System Documentation.
      1) Simplified system one-line schematic diagram showing changes made during construction.
      2) Complete inventory of system components including serial numbers. Identify location (equipment rack, over stage, stored in control room, etc.) of each component.
      3) Cable and terminal strip documentation including cable numbers, functions, originating locations, terminating locations, and signal levels.
4) All Shop Drawings corrected to reflect as-built conditions.
5) Other data and drawings required during construction.
6) Initial Tests and Adjustments data.
7) Final Tests and Adjustments data.
8) CD-ROM discs, USB storage or digital cloud transfer of documentation including all utilized manufacturer’s software and saved copies of software configurations (configurations as established during Final Tests and Adjustments).

Section 3 - Manufacturer's Documentation.
1) For each equipment model at no additional costs to Owner, even if manufacturer does not include costs of such documentation with purchase of equipment item.
2) Manufacturer’s Product Data.
3) Operating instructions.
4) Installation instructions.
5) Service information.
6) Schematic diagrams.
7) Replacement parts list.

Section 4 - Maintenance Information.
1) Preventive maintenance schedule letter clearly stating target dates of six month and end-of-warranty preventative maintenance inspections, and list of maintenance tasks performed.
2) Maintenance instructions including manufacturer's recommended maintenance, recommended maintenance schedule and information concerning proper inspection, testing, and replacement of components.
3) Troubleshooting information complete with instructions for procedures during equipment failure.

Section 5 – Warranty Information
1) System warranty letter.

4. Provide three (3) sets on CD-R disc, USB storage or digital cloud transfer that include all material in Operation and Maintenance Manuals in PDF format except for copyrighted material.

5. Submit one (1) set of Operation and Maintenance Manuals at least ten (10) days before Final Tests and Adjustments procedures (minus data from Final Tests and Adjustments). This set will be reviewed by Owner and returned to Contractor. Re-submit after Final Tests and Adjustments and include data. NOTE: Do not schedule Final Tests and Adjustments or perform training of Owner personnel before submitting Operation and Maintenance Manual.

6. Submit remaining number of complete manuals as required by General Conditions within ten (10) days after return of reviewed set(s). Include Final Tests and Adjustment data, warranty period letter, and any other data not included in first submission.

E. Samples
1. Request for Samples - Upon request, furnish samples (at no additional cost) to Owner and/or General Contractor of submitted items proposed as substitutes for specified items. Products will be reviewed to determine if proposed substitute items meet required function and quality.
2. Product Tests
   a) Products submitted as samples may require testing by independent laboratory. Testing at expense of Contractor.
   b) Obtain written approval of tested products before incorporating into system.

1.6 QUALITY ASSURANCE
A. AV Contractor Qualifications
1. Be established AV System Contractor, regularly engaged in furnishing and installing AV systems. NOTE: Electrical or general contracting firms responsible for completion of this work, but not meeting above requirement, shall employ services of approved AV Contractor as subcontractor to perform work described herein.
2. Be experienced in installations of similar size and scope within last five (5) years. Submit list of four (4) (minimum) installed jobs of similar magnitude, completed within last five years. For verification, submit complete information, including project name, project address, contact person, daytime telephone number plus month and year of project completion. At Owner’s request, accompany Owner or Owner’s representative on visit to any or all example completed projects submitted.

3. Be Authorized Dealer for all major lines of equipment listed in Part 2 (Biamp, Sony, Crown, Sharp, Crestron, etc.) Must have at least one permanent staff member who is factory trained in the installation and maintenance of each major product line offered.

4. Employ personnel (at all levels of work) experienced in projects of similar size and scope. Provide list of key personnel to be responsible for each of the following aspects of work: Project Management, Technical Documentation, Control System programming, DSP programming and Leadership of Field Work (one who is present for all field work). For each identified employee, indicate number of years employed by contractor, number of years’ experience in assigned responsibilities, and list of previously completed projects where similar responsibilities were required.

5. Project manager assigned to this project must have a minimum of five (5) years’ experience in installing and integrating AV systems of similar scale. Project Manager shall also have either an INFOCOMM CTS-I or CTS-D certification.

PART 3 PRODUCTS

2.1 GUIDELINES

A. All active AV equipment shall be furnished by AV Contractor selected by the Owner. All active electronics shall be contractor furnished, contractor installed (CFCI).

B. Infrastructure Products – All conduits, basket tray/cable tray, pull boxes and associated parts required for infrastructure shall be installed by the electrical contractor unless specifically excluded in these specifications or drawings.

C. Performance - Regardless of completeness of descriptive paragraphs herein, each device shall meet its manufacturer’s published specifications. Verify performance.

D. Contract Documents - Drawings and specifications are to be used in conjunction with one another and to supplement one another. In general, the specifications determine the nature and quality of the materials, and the drawings establish the quantities, details, and give characteristics of performance that should be adhered to in the installation of the AV system components. If there is an apparent conflict between the drawings and specifications, the items with the greater quantity or quality shall be provided and installed. Clarification with the owner about these items shall be made prior to the ordering and installation.

E. Quantities – All quantities are indicated on AV drawings or in Part 2 AV Products list. Confirm quantities on final Contract Documents. If Contract Documents do not include quantities necessary to deliver complete working system, provide notification of disparity, and install required quantity of devices for complete working system.

F. Small Parts - Systems are described in terms of major products. Even if not specifically mentioned, provide and install patch cables, connectors, hardware, converters, power supplies, labels, terminals, mounting accessories etc. necessary for complete and working system meeting design intent of specifications.

G. Balanced Lines – Unless specifically directed otherwise, wire all line and microphone level circuits as balanced with respect to signal ground. For products without balanced inputs or outputs, provide high quality balancing transformers with proper level, shielding, and impedance characteristics. Assure all audio levels arriving and leaving matrix and routing switchers are equal to the manufacturer’s recommended input audio level. If required, use Radio Design Labs, Inc. products or equivalent for level matching.

H. Keys - Provide five (5) sets of keys for any AV system product requiring keys.

I. Condition – Provide and install products listed in this section in factory new condition, conforming to applicable provisions of American National Standards Institute.
J. Designations - Each major product item is given unique designation (such as MIX1 for mixer number 1). The product designations are unique in this section only and may be repeated in other specification sections.

K. Security Screws - Use Middle Atlantic HSK Guardian Series button-head screws and bits to secure rack components, LCD mounts, Projector mounts and any other location deemed necessary by Owner. Use nylon washers (not provided by Bryce) to protect equipment surfaces. Account for appropriate tip wear when ordering quantity and do no use a bit beyond the manufacturer’s recommendations. Provide ten (10) additional unused driver bits and deliver to the customer after completion.

L. AV Electrical Power - Ensure that “Star” ground configuration is properly implemented by the Electrical Contractor. Ensure that ground wires from each outlet are isolated from conduit, neutrals, and each other and are each home-run back to the dedicated breaker panel for AV systems.

M. Wireless Microphones - Coordinate frequency selection with other radio-frequency sources in the area and with manufacturer’s recommendations.

N. Control System Programming:
   1. Program each panel to provide simple, intuitive control of all basic AV functions including: per zone program and speech volume levels, video and audio source and destination routing, AV system power, media player transport functions and CATV tuner control (including channel guide, navigation, last channel, channel select (up, down and manual input) and channel presets). In most applications program audio should follow video but allow subpage for additional audio routing. Provide one button macros for display, lighting preset and default input selection. Utilize owner provided graphic representing owner organization on startup screen and as a background on each screen. Provide auto start up function when plugging in devices to turn display on.
   2. Utilize Infocomm International’s (AVIXA) “Dashboard for Controls” concept for touch panel layout unless directed otherwise by Owner.
   3. AV management software shall be installed on Owner furnished computer(s) with adequate specifications per manufacturer’s recommendations.
   4. Provide layout of each and every touch panel and hard-button panel pages in the product data submittal for approval by Owner. Provide examples of touch panel options for color, button and icon styles for owner approval with submittals. 120 days before system testing provide to owner a page by page powerpoint or other document showing touch panel layout with descriptions of functions for approval.
   5. Provide web-control for each touch panel in AV system. Include page tracking, and track current button feedback between touch panel and web-control panel.
   6. Staff member certified by control system manufacturer shall program control system. Control programming must be done by in-house personnel. Programming cannot be subbed out to another contractor or individual.
   7. After programming is approved, all control system code and programming, including touch panel code and graphics, will become property of Owner. AV Contractor shall provide Owner both raw and compiled code on CD-R disc, USB media or Cloud transfer.

O. Audio System Programming - Owner shall coordinate layout and logical branching of DSP audio system. Include screen layout and menu branching drawings in AV submittal. After AV system is approved, all audio control system code and programming will become property of Owner. AV contractor shall provide virtual mixer web or desktop interface for mixer functions. Provide all DSP licenses required. AV Contractor shall provide Owner both raw and compiled code on CD-R disc.

P. EDID Configuration – The variety of resolutions of laptops and other computer devices that may be connected to these systems is unknown. Set preferred EDID settings to 1920x1080, 60Hz, 2-channel audio.

Q. AV Racks:
   1. Provide blank faceplate in any area marked BLANK in drawings.
2. Provide shelf for mounting of any device for which rack mount kit is not available.
3. Provide one Panelcrafters DATCO-XXXXX-RHIM-01 designer/integrator information plate or approved alternate per rack. Install information plate at the top of each rack unless 1RU space is not available. Contact Panelcrafters sales department to add AV Contractor graphic to the “integrator” section (approximately 8.5” x 1.75” of the right-hand side). All alternates must include AV Consultant graphic. Submit to AV designer for approval of final plate design prior to purchasing and installation.

R. AV Floor Boxes and Poke-thrus:
1. Clean floor boxes and poke-thrus of all dust and debris prior to installation of any active or connectorized plate.
2. Any floor box or poke-thru with active or connectorized AV plates found to have any dust, debris or water in bottom of box are subject to replacement of all plates and components. A re-test of all associated components must be completed.
3. Provide blank plates for all unused compartments in the AV floor boxes and poke-thrus.

S. AV Plates
1. The project standard plate color is white unless the plate is mounted on a wood or stone wall in which case it is to be stainless steel.

T. AV Design Bid & Substitutions:
1. System design is around products listed in Part 2. Intent of product specification is to provide standard of quality and function for installed materials. Certain performance specifications are given to clarify job requirements.
2. Bid AV system with products specified in section below unless noted otherwise from Owner.
3. No substitutions will be allowed without prior approval from Owner specific to proposed manufacturer and model numbers.
4. Equipment listed in Part 2 is based on performance criteria to meet Owner design requirements.
5. All requested substitutions need to meet or exceed performance of devices listed in Part 2. For each request provide manufacturer’s published specifications to verify performance and explain functional and cost impact.
6. Evaluation and approval of substitution requests will be performed by Owner.

2.2 ROOM DESCRIPTIONS
A. Huddle Rooms: Each room will have a flat panel display for presenting audio visual content. Media input sources include wired input and wireless presentation unit for WPD (wireless presentation device) presentation including wireless tablets and phones. Huddle rooms will use IR remote with flat panel display for switching source inputs.

B. Conference Room:
1. Wall Mounted Flat Panel Display.
2. HDMI connections located at table.
3. Wireless presentation device.
4. Table Microphones
5. OFE PC for software codec.
6. USB Camera connected to OFE PC.
7. Wall mounted speakers located at display.
8. Equipment rack with centralized audio, video and control equipment.
9. Wall mounted control panel with system on/off and volume up/down/mute

2.3 AV PRODUCTS
A. The following are major active and infrastructure products for this project.
1. AVP – AV Input Plate
   a) Type 1 – Custom two-gang AV plate
   b) Type 2 – Custom two-gang AV plate with one (1) passive HDMI connector with single gang mud ring
c) Type MRK - Custom 4-gang plate with four (4) decora style cutouts each with a brush pass-through

2. DSP - Audio DSP
   a) Biamp Tesira Forte AVB VT
      1) Biamp Tesira Connect 5 AVB Switch

3. WPD – Wireless Presentation Device
   a) Solstice Pod Mersive SP8000E3

4. NWS - Network Switch
   a) Pakedge SX8P

5. CC - Cable Cubby
   a) Type 1 – Extron Cable Cubby 202 with pass-through plates
      1) Coordinate mounting location with architect at control desk as required.

6. TPRX – Digital Twisted Pair Receiver
   a) Type 1 – Crestron DM-RMC-4KZ-100-C

7. TPTX – Digital Twisted Pair Transmitter
   a) Type 1 – Crestron DM-TX-4K-100-C-1G-B-T

8. FPD - Flat Panel Display
   a) Type 1 – Samsung QE82R 82” flat panel display
      1) Include Chief Manufacturing XSM1U wall mount
      2) Include active unbalanced to balanced audio converter for audio output
   b) Type 2 – Samsung QB50H 50” flat panel display
      1) Include Chief Manufacturing XSM1U wall mount
      2) Include active unbalanced to balanced audio converter for audio output

9. MIC – Microphone
   a) Type 1 – BIAMP TTM-XBLACK tabletop microphone
      1) TTXSM Microphone table mounts
      2) Biamp TTM-X Network Box

10. MRK – Millwork Rack
    a) Type 1 - Middle Atlantic CFR-16-23 furniture rack
       1) Include vent and blank panels as required.
       2) CAB-50, Fan kit
       3) PDT-1615CNS, Rear mounted power strip
       4) Small rack mountable UPS

11. PSW – Presentation Switcher
    a) Type 1 – Crestron DMPS-4K-150-C
       1) Use Extron Electronics ASA 131 passive audio summing adapters for incoming/outgoing balanced stereo audio signals.
       2) Include RS-232 extenders for cable runs over 50 feet.

12. PC – Owner Furnished Computer

13. S – Loudspeaker
    a) Type 1 – Innovox FP-V2P
       1) Powered Speakers Left and Right mounted at display.
       2) Follow manufacturer’s guidelines to paint speakers to match architect provided color sample

14. TP - Control Touch Panel
    a) Type 1 – Crestron TSW-1060-B-S
       1) Include PoE injector connected to building LAN
       2) Include tabletop kit as required
       3) Coordinate color selection with Architect

15. USB EXT – USB Extender
    a) Crestron USB-EXT2

16. WIRELESS KEYBOARD AND MOUSE
    a) Wireless Computing RF 772 wireless keyboard and mouse

17. Camera
2.4 CABLES

A. Interconnect Wiring – All AV cables will be plenum rated per NEC.
   1. Analog Audio Plenum Rated Cable - West Penn 25291, or similar.
   3. Analog Composite Video Plenum Rated Cable: West Penn 25806 or Belden 89120.
   4. RGBHV Plenum Rated Cable: Belden 1283S5, or West Penn 258195.
   5. Control Plenum Rated Cable: West Penn D25350.
   6. Loudspeaker Plenum Rated Cable: West Penn 25226B & 25227B.
   7. Shielded Cat7a Cable: Crestron DM-CBL-ULTRA
   8. Fiber 62.5 µm Cable: Corning 62.5/125.
   9. Interface/Adapter Cables: AMX or Extron Certified Cables
   10. HDMI Interconnect Cables: Extron Pro Series HDMI Cables

B. Connectors – All AV (including microphone) connectors shall be made by Canare or Neutrik.
   Connectors shall be of the quantity and type as required for proper and durable operation, and
   signal transmission of the electrical characteristics for associated circuitry.
   1. Microphone connectors: 3-conductor XLR AES/EBU compliant (for microphones in tables/lecterns, use Neutrik RF shielded connectors).
   2. Control panels: XLR type with number of conductors as required.
   3. Line level and left/right audio connectors: tip/ring/sleeve 1/4” phone jacks with insulated bushings.
   4. Composite video and RGBHV connectors: BNC dual crimp true 75 ohm BCP-C.
   5. BNC shall be made by ADC or Kings and be HD-SDI compliant to 3 GHz.
   7. Loudspeaker shall be Neutrik Speakon type.
   8. Provide strain relief for each and every connector.

PART 4 EXECUTION

3.1 INSTALLATION

A. General Guidelines
   1. Quality of Work - Perform labor to accepted industry standards and state and local codes to accomplish complete and working system.
   2. Material and Labor - Provide specified products and other incidental materials, appliances, tools, and transportation required for complete and functioning systems. Provide personnel to perform labor who are skilled in techniques and can demonstrate technical knowledge AV infrastructure system installations.
   3. Documents at Job Site - Keep following documents at job site during entire construction period:
      a) Complete Specifications and Drawings.
      b) Approved Shop Drawings.
      c) Approved Product Data.
      d) Progress Set of Project Record Documents.
   4. Mounting - Mount equipment and enclosures plumb and square. Ensure that permanently installed equipment is firmly and safely held in place. Design equipment supports to support loads imposed with project safety factor of five (5) or greater. For devices hung overhead, obtain review by Structural Engineer licensed by the appropriate governing authority prior to installation.
   5. Dimension Verification - Verify dimensions and space requirements to assure that proper mounting, clearance, and maintenance access space is available for system components.
6. Clean-Up - Leave project clean each day. Place debris where designated by General Contractor. Debris includes but not limited to: solder splatter, cable ends, stripped insulation, spent crimp connectors, gypsum board and ceiling tile dust, and product wrappings and cartons. After completion of installation, thoroughly clean areas worked, including non-visible areas such as equipment rack interiors, rack top panels, and inside lockable floor and wall boxes.

7. Coordinate installation of AV infrastructure and equipment with other trades in order to follow project schedule.

8. Maintain any licensing required by the appropriate governing authority to install and terminate low voltage systems.

B. Labeling

1. Equipment Labels - AV Contractor shall provide engraved laminoid labels on front and rear of rack-mounted equipment. Mount labels plum and square. Include schematic reference design, item name, and system or area controlled by labeled component. On program preamps and mixers, provide label for each input indicating which source is controlled by labeled channel. Unless otherwise indicated, provide permanently-mounted black labels engraved with 1/8-inch white block characters. Handwritten, self-laminating, or embossed plastic (Dymo) labels are not acceptable. Provide labels for major equipment with two (2) lines (minimum) of engraving, coded as follows:
   a) Line 1: Generic name of device, such as MIXER AMPLIFIER.
   b) Line 2: Schematic designation of device, such as AV-MSW-1.

2. Control Labels – AV Contractor shall provide engraved label over each user-operated control that describes the function or purpose of control. Provide label of proper size to fit available space.

3. Terminal Strip Labels - AV Contractor shall label each terminal strip with unique identification code in addition to numerical label (Cinch MS series) for each terminal. Show terminal strip codes on system schematic drawings included with Project Record Documents.

4. Rear Equipment Labels - AV Contractor shall provide adhesive label on rear of equipment where cables attach, to indicate designation of cable connected at each point.

5. Cable and Wire Labels - Label cables and wiring logically, legibly and permanently for easy identification. Labels on cables shall be adhesive strip type, covered with clear heat shrink tubing. Factory stamped heat shrink tubing may be used. Hand-written or self-laminating type labels are not acceptable.

6. Cable Label Codes and Locations - Label each cable with unique alpha-numeric code. Locate cable designation at start and end of each cable run, within three (3) inches of termination point. For cable runs that have intermediate splice points, label cable with same designation throughout, with additional suffix to indicate each segment of run. Provide cable designation codes to schematic drawings included with Project Record Documents and Operation and Maintenance Manuals.

C. Power and Grounding

1. Power Coordination – Coordinate final connection of power and ground wiring to rack. Electrical contractor will provide power to audio visual systems. Before installation, verify load requirements for systems as accepted.

2. Bus Bars - Install 1-inch by ¼-inch copper ground bus bar, top to bottom in floor mounted AV racks. Ground and bond equipment chassis of each rack-mounted component without three-pin grounding plug to bus bars with #12 AWG insulated green wire using 6-32 or larger nuts, bolts, lock-washers, and appropriate NEMA connectors. Electrical Contractor (Division 16) shall provide and connect #4 AWG green insulated wire from Bus Bars to ground point in AV technical electrical panel.

D. Equipment Racks

1. Ventilation - Provide ventilation adequate to keep temperature in rack below 85 degrees Fahrenheit. Use “whisper” type ventilation fans in racks, adjusted to come on when
temperature in rack rises above 85 degrees Fahrenheit, only if adequate cooling cannot be provided by Owner.

E. Wiring
1. Wiring Standards - Execute wiring in strict adherence to best AV engineering practices.
2. Field Connection Devices - Connect cable to active components through screw terminal connections and spade lugs when appropriate. For BNC connections use three-piece, dual crimp BNC properly sized for cable with insulating bushings. Wire nut or “Skotchlock” connectors are not acceptable. Do not wrap audio cable splices or connections with adhesive backed tape. Punch connectors or telephone-style punch blocks are not acceptable anywhere in the installation unless specifically authorized by Owner.
3. Run cable in ceiling plenums neatly parallel to building walls, supported every three feet to structure with plenum rated ties.
4. Raceways - Run vertical wiring inside rack in Panduit (or equivalent) plastic raceways with snap-on covers, sized to allow at least 50% future wiring. Mount raceways on full length ¾-inch flat black plywood backboards, attached to rack sides. If between-rack wiring chases are provided, Panduit raceways are not required. Horizontal wiring in rack shall be neatly tied in manageable bundles with cable lengths cut to minimize excess cable slack, but still allow for service and testing. Provide horizontal support bars if cable bundles sag. Individually bundle excess AC power cable away from rack mounted equipment with plastic cable ties. Electrical tape and adhesive backed cable tie anchors are not acceptable.
5. Accessibility - Ensure that wiring and connections are completely visible and labeled in rack. Mount termination resistors, if required, on terminal strips, fully visible and not concealed within equipment or connectors.
6. Loudspeaker Polarity - Connect loudspeakers electrically in phase, using same wire color for loudspeaker wiring throughout project.
7. Physical Damage Prevention - Take necessary precautions to prevent physical damage to cables and equipment. Damaged cables or equipment will not be accepted. Separate, organize, and route cables to restrict channel crosstalk and feedback oscillation.
8. Racks - Looking into the rack from the rear, locate AC power, control, data and speaker wiring on the left; line level audio, control, video, and RF wiring on the right. Keep several inches of space between power cables and other signals.
9. Hum Prevention - Ensure that electromagnetic and electrostatic hum is at inaudible levels. For line level signals, float cable shields at the output of the source device. Do not cut or remove shield conductors; fold back unconnected shields over cable jacket and cover with clear heat-shrink tubing. Do not obstruct cable labels.
10. Other Connections - Make connections using rosin core solder or approved mechanical connectors. Where spade lugs are used, crimp properly with ratchet type crimping tool. Solder spade lugs mounted on #22 AWG or smaller cable after crimping.

3.2 STORAGE AND HANDLING
A. Power up any electronic equipment to ensure its proper functioning before its arrival onsite.
B. Ensure that materials (especially electronic and electro-acoustic devices) are protected against physical, environmental, and electronic damage until final acceptance by Owner.
C. Schedule delivery to minimize delays in the project.
D. Provide storage protection against temperature and humidity extremes, theft, vandalism, physical damage, and environmental damage.

3.3 WARRANTY
A. Refer to Division 1.
B. Warranty - Submit letter providing warranty covering labor and materials supplied under this contract. Bind in Operation and Maintenance Manuals. Terms as described in General Conditions. Minimum terms as follows:
1. System - Systems shall be free of manufacturing or installation defects for a minimum period of one (1) year from the date of final acceptance. Clearly designate begin and end dates of system warranty period.

2. Parts and Labor - Provide parts and labor to repair defects in materials and workmanship during system warranty period.

3. Response Time - Within system warranty period, provide initial on-site service response within one (1) business day of service call. Provide resolution to any system defects within 72 hours or within 48 hours of receipt of repaired or replaced product from manufacturer.

4. Replacement Products - If any item must be removed for repair during system warranty period, provide replacement item of similar quality at no charge.

5. Repair Limit - Do not repair any piece of equipment found defective during installation or system warranty period more than two (2) times. After second repair, replace defective item with similar approved item at no additional cost to Owner.

6. Extended Manufacturer’s Warranties – Identify products with manufacturer’s warranties extending beyond one (1) year. Provide terms and conditions of such warranties.

7. Service Personnel Information - Provide name(s) and telephone number(s) of service personnel to be contacted regarding repair and maintenance.

C. Extended Warranty - Provide cost to extend complete AV system warranty from one (1) year to three (3) years. Included a list of all provided services including maintenance schedules.

3.4 INITIAL TESTS

A. Purpose – These tests are to ensure that the AV system is installed and functioning as specified, and to ensure the system is ready for Final Tests and Adjustments (described later).

B. Testing Standards – Perform testing in accordance with ANSI standards.

C. Inspection - Verify prior to beginning actual tests and adjustments on systems:
   1. Proper grounding of all electronic components (through third prong of power connector or separate connection between component chassis and ground bus bar).
   2. Cables dressed, routed, and labeled, connected with proper polarity.
   3. Insulation and shrink tubing in place.
   4. Dust, debris, solder splatter, etc. removed.
   5. Proper frequency settings (or modules) at crossovers and controllers.
   6. All equalizer bands and tone controls set for flat frequency response.
   7. Survey temperatures of each piece of equipment after four (4) hours use (minimum). Note and report any hot equipment.

D. Electrical Power Quality - While all sound and AV system components are unplugged from electrical power outlets, AV Contractor shall turn on power to outlets, and confirm proper voltages at each outlet across the following pairs of terminals: hot and neutral, hot and ground, and neutral and ground (zero volts across neutral and ground). AV Contractor to document measurements.

E. General Function Tests - Test each piece of equipment to ensure that it performs its intended function. Include all portable equipment in tests. Intent of initial tests is to verify complete, functioning system before Final Tests and Adjustments. Correct problems found during initial testing before beginning Final Tests and Adjustments. Document whether all pieces performed intended functions; note any unresolved malfunctions.

F. Initial Tests and Adjustments Data - Submit written report of Initial Tests and Adjustments data upon completion to Owner. Include printed name(s) of technician(s) performing tests, date(s) and time(s) of tests, model and serial numbers of test equipment, results of each initial test, descriptions of problems encountered and their solutions, and statement that system is ready for Final Tests and Adjustments. Initial Tests and Adjustments Data to include signatures of technician(s) performing tests.

3.5 FINAL TESTS AND ADJUSTMENTS
A. Purpose – These tests are to be witnessed by AV Consultant to determine if system is complete and functioning as designed and specified. Also, AV Consultant will perform listening and viewing tests and witness adjustments of all images for optimum clarity.

B. Timetable - Coordinate with Owner, General Contractor, and AV Consultant to schedule Final Tests and Adjustments after submittal of Initial Tests and Adjustments data.

C. System and Site Conditions – AV Consultant will witness Final Tests and Adjustments. Have systems fully functional and ready for observation and testing upon AV Consultant’s arrival. Coordinate with all trades for quiet conditions throughout the listening areas and for the duration of the test schedule. If upon AV Consultant’s arrival, systems do not meet criteria, site is not sufficiently quiet, or if Owner or AV Consultant is required to make additional trips to job site to witness additional testing or perform additional reviews of installed equipment, Contractor shall reimburse Owner for labor and expenses incurred by having incurred costs deducted from payments to contractor.

D. Test Labor - Provide technician familiar with this project’s AV systems and operation of test equipment to perform testing. Provide additional technician to assist in the tests and to perform troubleshooting, repairs, and adjustments. Include labor for these technicians to be present for one (1), eight (8)-hour day during Final Tests and Adjustments.

E. Tools - Provide standard hand tools including screwdrivers, pliers, wire strippers, nut drivers, soldering iron, and other tools appropriate for troubleshooting system problems.

F. Ladders and Scaffolds - Provide ladders and scaffolds to inspect/adjust loudspeakers and rigging points.

G. Verification of Initial Tests and Adjustments - Verify that Initial Tests and Adjustments have been performed and meet criteria. During Final Tests and Adjustments, AV Consultant may require portions of the Initial Tests and Adjustments to be repeated. Repeat measurements as requested without claim for additional payment.

3.6 FINAL ACCEPTANCE BY OWNER

A. Certificate – Submit Certificate of Final Acceptance form signed by Owner verifying complete installation and proper operation of systems upon fulfillment of all requirements and upon recommendation by Owner.

B. General Adjustments – Adjust, balance, and align equipment for optimum quality, meeting manufacturers published specifications.

C. Input/Output Jack Demonstration – Demonstrate proper performance and phase of each system input and output jack (all audio input and output jacks) as received at AV and network systems.

D. Inventory – Inventory all installed and portable equipment for correct quantities.

E. Functional Demonstration – Demonstrate operation of each function of each major piece of equipment.

F. Other Tests - Perform any other tests on any part of the AV system as requested by Owner.

G. Final Equipment Settings – Record final settings of all equalizer bands, tone controls, filters, delays, limiters, etc., including those established through computer software settings. Include descriptions of settings (including software settings) in Operation and Maintenance Manual. Include software copy of configuration file(s) in Operation and Maintenance Manual.

H. Security Inspection – Inspect equipment for security from tampering (covers, shaft-locks, etc.).

I. Review of Labels – Review installed labels on cables, equipment, controls, and terminal strips.

3.7 OWNER TRAINING

A. Provide Owner training as described in General Conditions. As a minimum, provide twelve (12) hours instruction (within four (4) trips to site) regarding AV Systems operation to Owner-designated personnel. Schedule instruction time(s) with Owner to occur after completion of Final Tests and Adjustments. Coordinate with Owner in advance to schedule instruction time.
Document date, time, and attendees of the training session and include documentation in Operation and Maintenance Manuals to serve as record of trained personnel.

3.8 SUPPORT DURING OWNER’S FIRST USE OF COMPLETED SYSTEM

A. Provide personnel familiar with design, installation, and operation of each system to be present at Owner’s first use of each completed system (up to six (6) hours total in two sessions). During first use of each system, respond to Owner requests for troubleshooting, adjustments, and additional training. If no one contractor employee or representative can provide expertise in all aspects of the system, provide multiple personnel for the six (6) hours per session as required. Schedule presence of personnel in advance with Owner. Should significant elements of the new system be operational prior to final completion, Owner may elect to schedule contractor presence for Owner function prior to final completion of system. Should Owner exercise this option, contractor presence will not be required at first use following final completion.

END OF SECTION
SECTION 28 0000

ELECTRONIC SECURITY

PART 1 - GENERAL

1.1 PROJECT SUMMARY/OVERVIEW

A. This document covers the general requirements for work to be performed to provide electronic security and surveillance.

B. The contents of this document, along with related drawings and other documentary material, are critical to the security of this project and Owner and shall remain secure and confidential.
   1. Confidential information shall not be deliberately or inadvertently disclosed to anyone other than the Contractor's personnel and subcontractors who require disclosure to perform their portion of the work.
   2. This confidential information shall be tracked to ensure that copies are accounted for and properly destroyed when no longer needed to perform the work.

C. The security systems shall consist of the following integrated subsystems as specified herein:
   1. Electronic Access Control and Intrusion Detection
   2. Video Surveillance
   3. Emergency Intercommunications and Duress
   4. Wire and Cable

D. Provide complete turnkey systems with the exception of those items noted within this specification as being provided by others.

E. Related Sections include:
   1. Section 087100 Door Hardware
   2. Section 260000 Electrical (including related sub-sections)
   3. Section 270000 Communications (including related sub-sections)
   4. Section 281000 Electronic Access Control and Intrusion Detection
   5. Section 282300 Video Surveillance
   6. Section 282600 Emergency Intercommunications and Duress
   7. Section 283100 Fire Alarm and Smoke Detection

1.2 GENERAL REQUIREMENTS

A. Upon completion of commissioning testing and Owner acceptance, DataCom Design Group bears no liability or responsibility for the continued proper operation of the installed systems.

B. The Items described herein shall not be modified or substituted without consent of DataCom Design Group and/or the Owner.
C. Electronic security systems integrator (security subcontractor) manager/supervisor shall attend meetings arranged by the Contractor, Architect, Owner or other parties affected by the work of this Section 280000.

D. If the manufacturer of security devices or connecting hardware has supplied post manufacture performance data, copies of such are to be kept for inclusion in the documentation and made available to the Owner upon request.

E. All materials are to be new unused and of the latest series of model number, unless otherwise indicated by the Owner or security system designer.

F. All materials shall be rated for the environment they are installed.
   1. All materials shall be UL- and/or ETL-approved and labeled in accordance with NEC for all products where labeling service normally applies.
   2. Materials and equipment requiring UL 94, 149 or 1863 listing shall be so labeled.
   3. Modification of products that nullifies UL labels is not permitted.

G. All security integrator personnel must be manufacturer certified and capable of an installation that falls under the manufacturer's guidelines necessary to obtain a manufacturer warranty.
   1. The integrator shall provide all components/materials essential for a complete and functional security access and surveillance system.

H. Security integrator shall issue a two (2) year warranty on installation and workmanship.

I. These Specifications and Drawings are intended for bidding purposes only, No part shall be copied or used for any purpose other than bidding on this project.
   1. This package shall be contractual upon bid award.

J. Drawings and Specifications are to be used in conjunction with one another and to supplement one another.
   1. In general Specifications determine the nature and quality of the materials and tests, and drawings establish the quantities, details and give characteristics of performance that should be adhered to in the installation of the security system components.
   2. If there is an apparent conflict between the drawings and specifications, or within the specifications themselves, the items with greater quantity or quality shall be estimated and installed.
   3. Clarification with the Owner/Designer about these items shall be made prior to purchase and installation.
   4. Questions regarding the Specification or system requirements should be directed in writing to DataCom Design Group or the Owner.

K. Security integrator shall adhere to Division 1 general requirements and written security Specifications and Drawings within this construction package and shall be responsible for complying with all local, state and federal laws or regulations applicable to the work being performed, even though said law, rule or regulation is not identified herein.

L. Security integrator shall arrange and pay for any inspections required by the public agencies having jurisdiction in the area.
M. The security contractor shall procure and maintain for the duration of this agreement, insurance
going against claims for injuries to persons or damages to property which may arise from, or conjunction with, the performance of the work hereunder by the security integrator, his agents, representatives, or employees.

1. The security integrator shall pay the cost of such insurance.

N. The security integrator will respect and protect the privacy and confidentiality of the Owner, his employees, processes, products, and intellectual property to the extent necessary, consistent with the legal responsibilities of the State of Texas and the Owner.

O. If required the security integrator shall sign a non-disclosure agreement and abide by its requirements to keep confidential all information concerning bid documents and this Project.

P. Furnish submittals and manuals in accordance with Division 1.

Q. Furnish a detailed material list complete with suppliers (distributors) list of components and distributors name, address, and phone number.

R. Refer to Specifications issued by Architect, Division 1, for Project and cost payments.

1.3 REFERENCES

A. The publications listed below form a part of this Specification. The publications are referred to in the text by basic designation only.

B. Specific reference in Specifications to codes, rules, regulations, standards, manufacturer’s instructions, or requirements of regulatory agencies shall mean the latest printed edition of each in effect at the date of contract unless the document is shown dated.

C. For conflicts between referenced requirements and contract documents comply with the one that is more stringent.

1. Federal, State, and Local codes, regulations and ordinances
4. NFPA 730: Guide for Premises Security
5. NFPA 731: Standard for the Installation of Electronic Premises Security
7. Building Codes (UBC) (IBC), latest editions
8. Occupational Health and Safety Act (OSHA)
9. Americans with Disabilities Act (ADA)
10. Local Governing Authorities Having Jurisdiction
11. Underwriters Laboratory (UL) Applicable Standards for Safety and Security
12. Institute of Electrical and Electronics Engineers (IEEE) Applicable Standards
13. Telecommunications Industry Association (TIA) Applicable Standards

D. Related Documents

1. Security Drawings
2. General provisions of contract
3. Uniform general conditions
4. Supplementary general conditions
5. Architectural plans & specifications
6. Requirements of Division 1
7. Electrical / Mechanical / Telecommunications specifications and plans.

1.4 DESCRIPTION OF SYSTEM WORK

A. Furnish and install all materials, tools, equipment, and services for all electronic security/surveillance devices to provide functioning systems in accordance with performance requirements specified and any modifications resulting from reviewed shop and field coordinated drawings.

1. Access Control System
   a) This system replaces the typical mechanical key controlled door lock with a door locking system that uses an access card as the access credential.
   b) The system includes an electric door-locking mechanisms, card reader located adjacent the door, door status sensor, door prop alarm and a request to exit device.
   c) Typical system configuration is card or schedule controlled entry with free exiting.

2. Intrusion Detection System
   a) This system monitors areas for unauthorized entrance or intruder.
   b) This system can consist of motion sensors, door status sensors, glass break sensors and one or more control keypads.
   c) The keypad is used to arm/disarm system by entering a numeric code on the keypad.

3. Video Surveillance System
   a) This system is used to provide video surveillance through the use of cameras of security sensitive areas and target items.
   b) The system shall allow for the viewing and recording of images.

4. Emergency Intercommunications and Duress Systems
   a) Duress Buttons
      1) These buttons, also known as panic buttons, are installed in locations where potential personal safety or security threats exist.
      2) Depressing the button sends a silent priority alarm signal to assigned monitor with location and specific alarm information
      3) The panic button is usually located in the knee space underneath a desk or service counter.
   b) Intercom / Call Stations
      1) The device typically is a distinct box or pole with a call button.
      2) Depressing the call button puts the individual in direct voice contact with assigned monitor along with specific location information.

B. RACKS AND ENCLOSURES
1. Wall mounted enclosures, data gathering panels, and power supply panels shall be installed as per manufacturer's requirements.
   a) Coordinate pathways and power with Electrical and Telecommunications Contractors
   b) Furnish all labor, materials, tools, equipment, and services for all control consoles, equipment racks, cabinets, and enclosures not provided by others in accordance with contract documents.
   c) Completely coordinate with work of other trades to avoid duplication in purchasing.
   d) Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, and devices incidental to or necessary for a sound, secure and complete installation.

2. The installation of the relay racks/cabinets for Electronic Surveillance shall be by the Telecommunications Contractor.
   a) Coordinate locations with G.C.

3. The installation of the relay racks/cabinets for Electronic Surveillance shall be coordinated with the Telecommunications Contractor and G.C.

4. The designated security space will provide an area reserved for rack and wall mounted security equipment.
   a) The rack area allows for vertical relay rack(s).
   b) Backboard wall area of 8'-0" X 8'-0" shall be reserved for wall-mounted components.
   c) Cable tray/ladder shall be by the telecommunications contractor and is provided to facilitate cable access into both wall and rack mounted equipment.

C. Provide all supplementary or miscellaneous items and devices incidental to or necessary for a sound and complete installation.

D. Drawings are representative and show general arrangement of systems and equipment, except when dimensioned or detailed.

1. For exact locations refer to dimensioned architectural drawings.
   a) Field measurements take precedence over dimensioned drawings.
   b) Field verify locations and arrangement of all systems and equipment.
   c) Coordinate all work with other trades and Contractor.

E. Circuit Supervision

1. Supervise all signal and data transmission lines, links with other systems, and sensors.
   a) Indicate circuit and detection device faults with both protected zone and trouble signals.
   b) Initiate an alarm in response to opening, closing, or shorting of a signal or data transmission line.

F. Electronics systems work as specified in this Section and Sections 281000, 282300, 282600 shall include:

1. A project kick-off/pre-submittal meeting with the Architect, Designer, and Contractor to review security design package.
a) Additional participants shall include:
   1) Division 8 subcontractors
   2) Division 26 subcontractors

2. Preparation of pre-installation submittals, including point-to-point wiring information for security equipment to interface to work by others prior to start of any installation work. Include lock permit requests in submittals for review.
3. Furnishing and installation of all security devices, components and accessories.
4. The furnishing and coordination on installation of special back boxes for security equipment and field devices as required.
5. Furnishing, installation and termination of all copper wiring and cabling including any special purpose wire and cable for electronic security systems.
   a) Coordinate all network and fiber optic cable interface provided by telecommunications subcontractor.

6. Coordinate raceway and power distribution systems provided by Division 26.
7. Provide and install 12/24 VAC/DC input power to all field devices as required.
8. Coordination with other trades and Owner required to facilitate the installation of the security equipment including:
   a) Division 08 (doors)
   b) Division 26 (power, raceways, and fire alarms)
   c) Division 27 (telecommunications network interface).

9. Wiring and termination of electrified door hardware by security subcontractor shall be concurrent with the installation of these electrified components by the door hardware subcontractor.
10. Programming of all security control equipment and prior coordination with the Owner’s security and telecommunications personnel.
11. Preparation of “As-Built” documentation.
12. Warranty service for completed work.

1.5 SUBMITTALS

A. Refer to Requirements of Division 1.

B. Pre-Installation Submittal Requirements

1. Submittals for electronic security shall be complete and submitted at the same time.
   a) No partial submittals will be accepted for review.
   b) Allow 2 weeks for consultant review of submittals.

2. General Requirements
   a) A functional description of each system.
   b) All cable and wiring types for each device type used.
   c) Written confirmation that lock wiring and access control systems requirements have been coordinated with electrified door hardware, fire alarm systems, automatic door controls, and overhead door controls specified in other sections and other packages.
   d) Power supply points listing with devices and maximum loads to prevent overloading.
3. Product Data Cut-sheets

a) Complete manufacturer's technical data including manufacturer warranty information, descriptive literature, illustrations, and installation instructions for all components included within this project indicating compliance with applicable referenced standards, size, dimensions, model number, electrical characteristics, support requirements, connection requirements and all applicable information verifying that submitted components comply with Contract Documents.

4. Shop Drawings

a) Floor plans necessary to identify specific device locations, cable routes and quantities, cable types, riser locations, and references to installation details and diagrams.

b) Riser diagram showing routes between floors or other areas that are not easily identified on the floor plans.

c) Security One-line diagrams showing all input and output points of the system.

1) The Contractor shall make any corrections required by the consultant team, file with him two corrected copies and furnish such other copies as may be needed.

2) The consultant's approval of such drawings or schedules shall not relieve the Contractor from responsibility for deviations from drawings or specifications, unless he has in writing called the Architect's attention to such deviations at the time of submission, nor shall it relieve him from responsibility for errors of any sort in shop drawings or schedules.

d) Release of CAD Files

1) Contractor may request to utilize DataCom's AutoCAD floor plan files for assistance in producing shop drawings.

2) Request shall be made by signing DataCom's "Agreement for Release of CAD Files" letter.

5. Warranty

a) The Contractor shall provide the appropriate documentation to comply with the requirements described in the WARRANTY section.

6. Qualifications

a) The Contractor shall provide the appropriate documentation to comply with the requirements described in the QUALITY ASSURANCE section.

C. As-Built drawings shall be in current AutoCAD format, same version as used by the Architect.

1. Dimensions and scale of the drawing sheets submitted shall match the size of the drawing used for the contract documents, and shall include the following.
a) Utilize normally recognized drafting procedures that match AutoCAD standards, Architect, and Designer guidelines and methodology.

b) The As-Built drawings shall incorporate all changes made to the building identified in, but not limited to, Addenda, contemplated change notices, Site Instructions or deviations resulting from site conditions.

c) Dimensioned plan and elevation views of all security components.

d) Cable routing paths of security cables to identified infrastructure pathways.

e) All rack, cabinet, and enclosure locations and labeling thereof.

f) One-line diagrams of equipment/device interconnecting cabling of the security systems.

g) Standard or typical installation details of installations unique to Owner’s requirements.

h) Submit one soft and one hard copy with project deliverables within 30 days of project completion.

D. Security integrator shall provide three (3) paper copies and one (1) electronic copy (PDF format) of a properly indexed O&M Manual at the conclusion of the project, which will include, but not be limited to the following requirements:

1. Ring binder with project title, properly indexed, and contractor’s name on cover and spine including:

   a) Sequence of operations, design philosophy, and specific functions

   b) System block diagram

   c) Equipment list including:

      1) A brief description

      2) Model

      3) Total number of each item used in the project.

   d) Camera schedule including:

      1) Number

      2) Location

      3) Camera model/manufacturer

      4) View

      5) Lens

      6) Power source

      7) Multiplexer/input

      8) Settings entered on site

   e) Manufacturers’ data sheet and O&M manual for associated equipment.

   f) Maintenance requirements for equipment, inspections and preventative maintenance schedules.

   g) As-built drawings for each floor plan layout and rack and wall elevation layouts. Each drawing shall show:

      1) Cable type and identifier

      2) Actual cable routing pathway

      3) Device number (camera, etc.),

      4) Device input/output number.

   h) Final test data (measured video levels, day & night camera snapshots in JPEG format and other significant operating parameters).
i) List of system associated mechanical locking keys with key codes and tamper resistant hardware types.

1.6 QUALITY ASSURANCE

A. Electronic security systems integrator (security subcontractor) shall meet the following minimum requirements.

1. Maintain a valid Type B license from the Texas Private Security Bureau.
2. Have successfully completed three (3) projects of similar size and complexity that have been in proper operation for a period of one (1) year.
3. Technicians shall be factory trained and certified in specified systems.
4. The Project manager and supervising/lead technician shall have been regularly engaged in the installation and testing of the products specified for not less than five (5) years and maintain manufacturer certification.
5. The security integrator must maintain an operating facility in the local area (50 mile radius) of the Project location to provide service to the Owner for the warranty period.
   a) At the Owners request for service, the security integrator shall dispatch a service technician to the location to affect the required repairs or adjustments.

6. The contractor shall maintain a spare parts inventory necessary to resolve component failures of the system.
   a) Refer to individual specification section for a list of specifically required parts provided to the owner and stored on site. These parts will become the property of the owner.
      1) At the end of the warranty period the security integrator shall test the owner’s spare parts and repair or replace as needed to bring the parts up to proper operation.

7. A BICSI RCDD shall approve all on-site work as a recognized member of the Contractor’s installation team.
   a) All installation team members must demonstrate knowledge and compliance with all BICSI, TIA/EIA, UL, and NEC methods, standards and codes.

B. Security integrators desiring approval must comply with Division 1 requirements.

C. Security integrator must be cognizant of site conditions, verify locations of new and existing equipment, and determine exact requirements for connection and interface.

1.7 PRE-INSTALLATION MEETINGS

A. Attend and/or arrange a scheduled pre-installation conference prior to beginning any work of this section.
   1. Agenda
a) This venue is to ask and clarify questions in writing related to work to be performed, scheduling, and coordination with the Project manager/Owner representative and consultant.

2. Attendance

a) The security project manager/supervisor shall attend meetings arranged by General Contractor, Owner’s representatives, and other parties affected by work of this document.

b) All individuals who will be installers of the electronic security system and equipment in an on-site supervisory capacity, including project managers and lead installers, shall be required to attend the pre-installation conference.

c) Individuals who do not attend the conference will not be permitted to install, or supervise the installation of, any component of the security system.

1) This includes supervisors, project managers, and lead installers of this project.

1.8 POST INSTALLATION MEETINGS

A. At the time of substantial completion the contractor shall call and arrange for a post installation meeting to present and review all submittal documents to include but not be limited to As-Built Drawings, Warranty paperwork, etc.

1. Attendees to be invited shall include:

a) Project manager/Owner representative
b) DataCom Design Group
c) General Contractor
d) Other trades that the GC deems appropriate.

2. At this meeting the contractor shall present and explain all documentation, asking for feedback on its completeness.

3. Any discrepancies or deviations noted by and agreed to by participants shall be remedied by the contractor and resubmitted within one week of the meeting.

1.9 DELIVERY, STORAGE AND HANDLING

A. Equipment and components shall be delivered properly protected and undamaged with original containers, packaging, and labels intact.

B. Store, handle, and protect all related materials and equipment in accordance with Manufacturer's recommendations.

C. Provide additional protection during handling as necessary to prevent breaking, scraping, marring, or otherwise damaging products or surrounding areas.

D. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust, or other contaminants.

1. Equipment damaged prior to system acceptance shall be replaced at no cost to the owner.
E. Protect all equipment and components that are to be installed from theft, vandalism, or use by unauthorized persons.

1.10 PROJECT/SITE CONDITIONS

A. Security integrator is responsible for conducting a site survey prior to the commencement of work to determine locations of all existing security devices and verify the proposed locations of the new components to be installed.

B. Security integrator will coordinate all work through the Contractor and schedule work to cause as little interference or interruption of existing services as possible.

C. Security integrator will arrange and pay for all necessary permits, licenses, and inspections.
   1. Security integrator shall prepare all information necessary to obtain a permit for Electronic Locking Mechanisms in compliance with the Owner requirements.

D. Verify with Division 26 installer all conduits and special back box requirements in a timely manner.

1.11 WARRANTY

A. See requirements in Division 1 Specifications.

B. The Security Integrator shall warrant all completed work, including all materials and labor, to be free from defects in design, workmanship, and/or materials for a period of two (2) years from final acceptance date.
   1. System acceptance is defined as the completion of all functional performance testing and the resolution of all punch list items.

C. Warranty Service
   1. In the event that defects in the materials and/or workmanship are identified during the warranty period, the contractor shall provide all labor and materials to correct the deficiency.
   2. All service work shall be performed by factory certified technicians.
   3. All warranty service shall include the replacement of all parts and or components as required to restore normal system operation.
      a) If parts or components need to be repaired, a loaner will be supplied and installed until the part or component can be repaired and reinstalled.
   4. Immediately following a warranty service request, the Contractor shall provide written documentation to Owner which details the service work completed, cause of trouble, and any outstanding work required to restore a complete and normal system.

D. Warranty service requests shall be responded to within 4 hours of notification with a qualified service technician on site.

E. All repairs shall be completed within 48 hours upon site arrival.
1. If the failure exceeds 48 hours, the Owner reserves the right to require the contractor provide on-site manufacturer support at no additional cost to Owner.

F. Extended warranties on equipment components offered by the manufacturer shall be passed through to the Owner.

1. Warranty provisions shall be fully transferable only at the direction of the Owner, in the event that ownership of the installed security systems is transferred.

1.12 SYSTEMS STARTUP AND TRAINING

A. After all systems have been tested, accepted and turned on for operation, the Security integrator shall provide "User Training" to Owner personnel.

1. The onsite training shall cover all newly installed electronic security components, devices and systems. The training classes shall total a minimum of twenty (20) hours for up to eight (8) people of the Owner’s choosing.

2. Two (2) separate training sessions will be conducted, one for system operators and one for system administrators.

3. The contents of the manuals will include:

   a) Title page with subject, system name, owner’s name, and an owner approved confidentiality notice.
   b) Table of contents.
   c) Manual that details system and sub-system operation.
   d) Manuals that details system administration procedures and tasks.
   e) Manuals that fully detail all programming commands.

4. Provide ten (10) Bound hardcopy System Operation training manuals and one electronic copy (PDF format).

5. Provide two (2) Bound hardcopy System Administration training manuals and one electronic copy (PDF format).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer’s are shown in individual specification sections.

B. Equipment manufacturers and model numbers indicated in individual specification sections are identified as minimum equipment requirements.

C. All substitutions shall meet or exceed these minimum requirements and must be approved by the Owner/Architect prior to purchase.

D. All manufacturers’ equipment shall be available through a nationally recognized supplier network.

2.2 EQUIPMENT
A. Provide security fasteners on all equipment, device plates, etc. within public areas.
   1. Allen head with center pin, hardened steel.
   2. Provide four (4) fastener tools to Owner.

B. Equipment installed in exterior applications shall be fitted with fasteners and exposed surfaces of stainless steel or other corrosion resistant material.

C. All materials and equipment used must be new and unused, prime quality products.

D. All equipment or components installed on the exterior of a building where the equipment is subject to adverse weather/elements shall be enclosed in weatherproof enclosures.

2.3 WIRE AND CABLE

A. All wire and cable shall be U.L. approved for its intended application and shall meet or exceed manufacturer’s recommendations for the components connected.

B. All conductors and cable shall meet individual security system manufacturer specifications.
   1. Provide shielded conductors and cable as required by the manufacturer or as required to provide for interference-free signals.
   2. Color coding shall be accomplished by using solidly colored insulation.
      a) Grounding conductors, where insulated, shall be colored solid green or identified with green color as required by NEC.

C. Increase conductor sizes on cables as required to be consistent with circuit current ratings, length of wire runs, and manufacturers’ recommendations.
   1. Alarm device field wiring shall be in accordance with the equipment manufacturer’s specifications.
   2. Low voltage power circuits shall use conductors as required by the equipment manufacturer’s specifications.
   3. Plenum rated cable shall be used as required by code.

D. UTP Structured Cabling Systems for IP cameras and intercoms (including pulling, terminating, and testing) by Division 27 Telecommunications contractor.
   1. Intra-building data communications circuits shall utilize UTP cable as specified in Telecommunications specifications.

E. Fiber Optic Structured Cabling Systems for IP cameras and intercoms (including pulling, terminating, and testing) by Division 27 Telecommunications contractor.
   1. Inter-building and building exterior data communications circuits shall utilize fiber optic cable as specified in Telecommunications specifications.

F. Patch Cables
   1. Provide pre-manufactured patch cables (cable, connectors, boots, etc.) as required to connect security systems to voice and data communication outlets.
2. Patch cables shall be certified for their specific use to meet or exceed applicable industry specifications.
3. Provide cable lengths as necessary to neatly route cables through cable management systems and other cable organization systems.
4. Provide connectors as required for proper termination.
   a) Provide boots for connectors where applicable to prevent snagging.

G. The minimum conductor sizes are for distances as per the manufacturer’s specifications from security device to security panel.
   1. The contractor shall size the conductor accordingly for longer runs.
   2. Minimum Conductor and Cable Types and Sizes.
      a) Alarm device field wiring shall be 18/20 AWG stranded copper conductors.
      b) Low voltage power circuits will use 18 AWG stranded copper conductors.

      1) Increase conductor gauge consistent with circuit current requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All personnel working on this project shall be experienced, highly skilled installers with a minimum of three (3) years work on similar type projects.

B. Changes in location of any work require the written approval of the Architect/Owner prior to initiation.

C. Changes in indicated sizes shall not be made without the written approval of the Owner/Architect.

D. Install all equipment in accordance with manufacturer’s recommendations.

E. All systems shall be designed and installed to provide 24 hour a day, 7 days a week operation.

F. Primary pathways
   1. All security cabling run from rack/enclosure head-end equipment to security devices shall follow primary telecom routing pathways.
   2. Security wire non-UTP cabling shall be kept separated from the data cabling
   3. Security wire non-UTP cabling shall be routed in bridle rings secured to the outside of the telecom tray where applicable.
      a) Arlington loops or J hooks shall be used where telecom pathways are not present
   4. Provide all necessary anchoring devices and supports.
      a) Use structural supports suitable for equipment, or as indicated.
      b) Check loading and dimensions of equipment with shop drawings.
      c) Do not cut or weld to, building structural members.

G. Secondary pathways
1. Arlington loops or J hooks shall be used for secondary pathways
2. Security wire non-UTP cabling shall be kept separated from the data cabling
3. Provide all necessary anchoring devices and supports.
   a) Use structural supports suitable for equipment, or as indicated.
   b) Check loading and dimensions of equipment with shop drawings.
   c) Do not cut or weld to, building structural members.

H. Conduits

1. All conduits shall be UL listed and comply with NEC requirements.
2. Routing
   a) Conduits shall be routed in the most direct route possible, with the fewest number of bends possible.
   b) There shall be no continuous conduit sections longer than 100'-0" for premises conduits. For runs that total more than 100'-0", insert junction or pull boxes so that no continuous run between pull boxes is greater than 100'-0".

3. Fill and Bend Radius
   a) Conduit fill shall comply with NEC requirements.
   b) There shall be no more than two 90° bends (180° total) between conduit pull boxes.
   c) Unless otherwise noted in the drawings, conduits entering pull boxes shall be aligned with exiting conduits.

4. Penetrations
   a) All conduit penetrations shall comply with all applicable fire codes.
   b) All conduit penetrations in fire-rated walls or floors shall be sealed and fire-proofed to meet or exceed the designed rating of the penetration area.

5. Conduit Fittings
   a) All fittings shall be compression or threaded.
   b) Fittings shall provide a secure connection for pulling cables.
   c) Setscrew fittings are not permitted.

6. Measured Pull Tape
   a) Pre-lubricated, woven polyester, low friction, and high abrasion resistant yarn with footage markers printed on the tape.
   b) Minimum average tensile strength shall be 1130 lbs. for 0'-1.5" and smaller conduits and innerduct.
   c) Minimum average tensile strength shall be 1800 lbs. for conduits larger than 0'-1.5".

I. Junction Boxes and Back Boxes

1. Junction boxes and back boxes shall be UL listed and comply with NEC requirements.
2. Junction box and back box installations shall comply with all applicable fire codes.
3. All junction box and back box installations in fire-rated walls or floors shall be sealed and fire-proofed to meet or exceed the designed rating of the wall the box is installed in.
J. Coordinate extension and connection to commercial, emergency/UPS power circuits provided by Division 26.

1. Make power connections in accordance with Division 26.

K. Shielded and/or screened cables shall be grounded per the hardware manufacturer’s instruction.

1. Single point shield grounds shall be grounded at the field panel feeding the device or sub panel and insulated from ground at the termination end of the cable.

L. All installation of security systems shall be complete at least thirty calendar days prior to occupancy.

3.2 RACK AND CABINET INSTALLATION

A. Coordinate rack/cabinet installation with Telecommunications contractor and follow provisions in Section 281000.

B. Rack installation by Telecommunications contractor.

C. After racks are installed, install all required components to support rack mounted security equipment.

1. Extend UPS/emergency power to rack mounted equipment as required.

D. Install all conduits, back boxes, wire and cable management as required for interconnection of security equipment, data gathering panels, power supply enclosures, and distribution panels in the Security room.

E. Extend commercial/emergency/UPS power circuits as required to security components as required.

F. Neatly lace and dress all cables in each rack.

1. All wiring and cable shall be properly supported.
2. Utilize suitable cable management devices, no tie-wraps for UTP structured cabling allowed.

3.3 GROUNDING AND BONDING

A. Equipment Cabinets and Racks

1. To provide electrical continuity between rack elements, paint-piercing grounding washers shall be used where rack sections bolt together, on both sides, under the head of the bolt and between the nut and rack.
2. A horizontal busbar shall be installed at the top and back of each rack for floor fed cabinets/racks.
3. A vertical busbar shall be installed to the rear of the right-hand side rail with thread-forming screws to ensure metal-to-metal contact.
4. Each rack shall be provided with a minimum # 6 AWG insulated ground wire.
5. Do not bond racks serially (loop from rack to rack).
6. Each rack bay against a wall shall be bottom/side ground feeds from the wall.
a) Wall ground feeds/raceways to racks shall not be exposed on the walls.
b) Exception

1) Some rack bays will require the ground to be fed from the ceiling raceway. Refer to drawings for details.

7. The Contractor shall provide a ground strap for each equipment rack and bond to the nearest Telecommunications Bonding Backbone (TBB) connection, Furnish all required bonding materials and hardware manufactured for this purpose.

a) Follow NEC bonding procedures/specifications.

8. All ground raceways within each rack shall be an insulated metallic flex type raceway and shall not interfere with equipment mounting frames or equipment mounting brackets.
9. Each ground feed shall provide proper installation allowances and penetration depths to provide conversion fittings from solid metallic to insulated metallic flex conduit raceways.
10. To bond each rack to ground, burnish clean a one square inch area, drill, tap, apply an adequate amount of antioxidant joint compound mixed for the metal surface types affected, and bolt connectorized conductor to burnished and compounded area.

a) Ensure proper conductivity.

B. Cable Runway, Cable Raceway and Support System Grounding

1. The Contractor shall provide communications cable tray and cable runway systems with a communications isolated ground from the TBB.
2. All cable tray needs to be electrically continuous per NEC 250.96.

a) Metal raceways, wire-mesh cable trays, cable armor, cable sheath, enclosures, frames, fittings, and other metal non-current-carrying parts that are to serve as an alternate grounding path, with or without the use of supplementary equipment grounding conductors, shall be effectively bonded where necessary to ensure electrical continuity and the capacity to conduct safely any fault current likely to be imposed on them.

b) Any nonconductive paint, enamel, or similar coating shall be removed at threads, contact points, and contact surfaces, and be connected by means of fittings designed so as to make good bonding points.

3. The Contractor shall provide and install #6 AWG insulated ground wire to bond one end of each cable tray/runway system to the #2/0 TBB.
4. For electrically non-continuous conduits that contain only grounding conductor, the Contractor shall bond the conduit and conductor together at both ends to ground to nearest TGB with grounding bushings or ground clamps.

3.4 LABELING

A. Provide labeling for all security equipment components using waterproof, self-adhesive computer printed labels.

1. Coordinate with Owner on numbering/labeling scheme.

B. Provide labeling for all security cable/wiring using waterproof, self-adhesive computer printed labels.
1. Coordinate with Owner on numbering/labeling scheme.
2. Label all cables/wiring on both ends.
3. At multi conductor cable terminations label each conductor.
4. At a minimum, each cable/wire label shall designate:
   a) Origination Point
   b) Alarm point description
   c) Opening description (if applicable)

C. Provide a complete cable/wire identification plan/list with project completion submittal.

D. Conduit and junction box exteriors may be identified with unique color paint, but shall not be identified with written words that easily identify the function of the conduit and boxes.

3.5 POWER REQUIREMENTS

A. 120 VAC emergency power dedicated to security will be provided. (By Electrical Contractor)

B. Back-up power for all equipment and devices shall be for at least 4 hours unless otherwise specified.
   1. When generator backup power is available, provide a UPS, rated to maintain the load for a minimum of 15 minutes for all 120VAC equipment.

C. Rack-mounted Uninterruptible Power Supply (UPS)
   1. Provide a UPS to support 120% of the required load to allow for future load expansion and age related deterioration of the battery performance.
   2. The UPS interface port shall have an RS-232 communications port and a 10 Base-T Ethernet for LAN management.
      a) Provide the necessary data connection, hardware and software to remotely monitor the UPS
      b) Provide user configurable computer operating system shutdown capability
   3. The control panel shall have a LED status display for load and battery bar graphs in addition to replace battery and overload indicators.
      a) Rack-mounted surge suppression shall be vertically mounted and made for this orientation.

D. All electronic locks shall be 12/24VDC (By Division 08)

E. Connect to AC power and provide UL listed power supplies and transformers to distribute low voltage power to the system components as required.
   1. Provide uninterrupted battery backup power for the duration required above.

F. All equipment connected to AC circuits shall be protected from power surges.
   1. The devices shall be installed and grounded per manufacturer instructions.
   2. Equipment protection shall meet requirements of ANSI C62.41.
   3. Fuses shall not be used for surge protection.
G. All non-fiber optic data circuits that serve devices exterior to the buildings will be protected by surge protectors at the device and the termination.

1. The devices shall be installed and grounded per manufacturer instructions.
2. Equipment protection shall meet requirements of ANSI C62.41.
3. Fuses shall not be used for surge protection.

3.6 TESTING

A. Ensure that all provisions and requirements of this specification are met.

1. Verify through inspections, demonstrations and tests.

B. Perform required tests to demonstrate workmanship, operation, and performance.

1. Conduct tests with Architect/Owner and if required, inspectors of agencies having jurisdiction present.
2. Arrange test dates in advance and give all parties a minimum of 48 hours notice.

C. Repair or replace equipment or systems found defective or inoperative and re-test until 100% satisfactory results are obtained.

D. Verification inspections will be made of all equipment components and installations for proper functioning of locking hardware and lock controls, mounting/placement of sensors, and cameras, etc. to guarantee requirements of the Contract Documents are complied with.

1. The Owner’s quality control representative shall have the opportunity to witness all inspections, or to conduct installation inspections of his own.

3.7 FUNCTIONAL PERFORMANCE TEST

A. The Functional Performance Test (FPT) will be conducted at the end of the project and prior to system acceptance by the Owner.

1. The security integrator will provide all necessary staff and communications needed to fully test all functions of the system.
2. The contractor will submit for approval by the Architect and Owner, a comprehensive test plan that will include testing of every function on every door and security device thirty (30) days prior to the scheduled start of the test.
3. The system will not be considered for acceptance prior to the successful completion of the FPT and completion of punch list items.

B. Pre-Testing

1. Following installation and prior to the FPT, the security integrator shall individually test each component and field device and verify the proper functioning of each component within a particular sub-system.
   a) The contractor shall also test each sub-system until all detection zones, alarm assessment components, alarm reporting, surveillance and display components; along with access control functions have been verified.
   b) Prior to the FPT all deficiencies must be corrected.
c) After sub-system verification is complete, test the entire system to assure that all elements and subsystems are compatible and function properly as a complete system.

C. Upon completion of the outlined tasks and tests the security integrator shall schedule the FPT with the Architect and Owner.

1. The security contractor must demonstrate that the security system components and subsystems operate together as a system and meet specification requirements in the “As-Installed” operating environment.
2. On conclusion of the FPT the test report document will be submitted to the architect for approval.
3. The FPT will be observed by the architect’s and Owner’s representatives.
4. The FPT may be stopped at any time by these representatives if they believe the failure rate is too high or the system is not performing to contract document requirements.
5. The FPT will only resume when all deficiencies have been corrected.
6. Retesting will be required of all failed tests.

3.8 SYSTEM OPERATIONAL TEST

A. Upon completion of the FPT, conduct a formal test to be known as the System Operational Test (SOT), in which all components and sub-systems of the security system are demonstrated to operate error and failure free together as a system.

1. This test is to be performed over a continuous seventy-two (72) hour period.
2. A formal test plan and test procedures shall be prepared by the security subcontractor and submitted to the Owner/Architect for approval.
3. The Security integrator must demonstrate that the system components and sub-systems meet specification requirements in the “As-Installed” operating environment and operate error and failure free for the duration of the test.
4. If a system failure does occur, the failure must be documented and repaired, after which the seventy-two hour SOT period will restart.

B. In the event that the Owner, Architect, or Contractor are required to witness a retest at a later date because the Security integrator is not properly prepared to conduct the acceptance tests or because the systems being tested have failed such tests, which shall be solely determined by the Architect or Owner witnessing the tests, the cost of witnessing additional tests shall be borne exclusively by the Security integrator.

1. Costs are to be based on time and materials at the established rates of the Architect or Owner.
SECTION 28 3100
FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. The requirements of Division 01, General Requirements and other provisions of the contract documents apply to this work.

B. This Section intends to describe an integrated fire detection and voice evacuation system to be intelligent device addressable, analog detecting, low voltage and modular with multiplex communication techniques, in full compliance with all applicable codes and standards. The features described in this specification are a requirement for this project and shall be furnished by the successful contractor.

1. The system as described shall be installed, tested, and delivered in full operating condition. The system shall include all required hardware, raceways, interconnecting wiring and software to accomplish the requirements of this specification whether itemized or not.

2. All equipment furnished shall be new and the latest state of the art products of a single manufacturer, engaged in the manufacturing and sale of analog fire detection devices for over ten years. The equipment manufacturer shall have an installed base of analog systems as a reference. In the interest of job coordination, the installing contractor shall contract with a single source for supplying job materials, services, and programming, including final inspection/test services for the fire alarm system.

3. The equipment, space requirements, expansion capabilities and features specified were selected to meet the requirement for this project
a. Manufacturers. All requirements listed in this specification shall apply to all manufacturers. Listing as acceptable shall not be construed as approval for equipment not performing to the requirements set forth herein.
   1) Notifier. (Basis of Design / Existing System)

1.2 MATERIALS AND SERVICES

A. The system shall include, but not be limited to the following elements:

1. Master system CPU including all fire detection, voice/audio and visual evacuation alarm control modules, supervised power amplifiers with the required back up modules.

2. Circuit interface panels including all modules.

3. Power supplies, batteries and battery chargers.

4. Pre-amplifiers, amplifiers, and tone generators.

5. Equipment enclosures.

6. Intelligent addressable manual pull stations, heat detectors, analog smoke detectors, alarm monitoring modules, and supervised control modules.

7. Annunciator panel and printer.

8. Voice/Audible and visual evacuation signals.

9. Color graphic displays and historical archiving.

10. Software and firmware as required to provide a complete functioning system.

11. Wiring and raceway.

12. Installation, testing and certification and training.
13. Interface with security system per Paragraph 1.10.
14. Interface with air handling units.
15. Connection to MDF room via fiber for remote monitoring.

1.3 REFERENCE STANDARDS

A. The publications listed below form a part of this publication to the extent referenced. The publications are referenced in the text by the basic designation only. The latest version of each listed publication shall be used as a guide unless the authority having jurisdiction has adopted an earlier version.

   d. NFPA 72 National Fire Alarm and Signaling Code (2013)
3. Underwriters' Laboratories, Inc. (UL).
   a. Appropriate UL Standards.
   b. UL FPED.
4. Texas Department of Licensing and Regulation.
5. Americans with Disabilities Act.

1.4 QUALIFICATIONS OF THE INSTALLER

A. Before commencing work, submit data showing that the contractor has successfully installed fire alarm systems of the same type and design as specified, or that they have a firm contractual agreement with a subcontractor having the required manufacturers' training and experience. The contractor shall include the names and locations of at least two installations where the contractor, or the subcontractor above, has installed such systems. Specify the type and design for each system and furnish documentation that the system has performed satisfactorily for the preceding 18 months. Layout to be performed and installation to be supervised by a licensed supervising fire alarm planner with the Texas State Fire Marshal's Office as a minimum.

1.5 MANUFACTURER'S REPRESENTATIVE

A. Provide the services of a representative or technician from the manufacturer of the system, experienced in the installation and operation of the type of system provided. The representative shall be licensed in the State of Texas. The technician shall supervise installation, software documentation, adjustment, preliminary testing, final testing and certification of the system. The technician shall provide the required instruction to the Owner's personnel in the system operation, maintenance and programming.
1.6 SUBMITTALS

A. The contractor shall include the following information in the equipment submittal:

1. Power calculations.
   a. Battery capacity calculations. Battery size shall be a minimum of 150% of the calculated requirement.
   b. Supervisory power requirements for all equipment.
   c. Alarm power requirements for all equipment.
   d. Power supply rating justification showing power requirements for each of the system power supplies. Power supplies shall be sized to furnish the total connected load in a worst case condition.
   e. Justification showing power requirements of the system amplifiers.
   f. Voltage drop calculations for wiring runs demonstrating worst case condition.

2. Complete manufacturer's catalog data including supervisory power usage, alarm power usage, physical dimensions, finish and mounting requirements.

3. Submit panel configuration and interconnection of modules and all other data as required to make an informed judgment regarding product suitability. At a minimum, data shall be submitted on the following:
   a. Master system CPU including all fire detection, voice/audio and visual evacuation alarm control modules, and supervised power amplifiers with the required back up modules.
   b. Circuit interface panels including all modules.
   c. Power supplies, batteries and battery chargers.
   d. Pre-amplifiers, amplifiers, tone generators, master microphone and master telephone.
   e. Equipment enclosures, including dimensions and weights of completed units.
   f. Intelligent addressable manual pull stations, heat detectors, analog smoke detectors, alarm monitoring modules, and supervised control modules.
   g. Annunciator panel and printer.
   h. Audible and visual evacuation signals and devices.
   i. Software and firmware as required to provide a complete functioning system.
   j. Circuiting, including conduit and wire sizes.

4. Data describing more than one type of item shall be clearly marked to indicate the type the contractor intends to provide for options not crossed out in submittal material will be furnished for the project. All submittal material shall be complete. Partial submittal will not be evaluated and will be rejected without comment. The contractor shall submit copies of UL listing or FM approval data showing compatibility of the proposed device or appliance and the panel being provided.

5. Complete drawings covering the following shall be submitted by the contractor for the proposed system:
   a. Floor plans showing all communicating, initiating, end of line, supervisory, indicating appliances, and output control devices; including circuit interface panels, message digitizers, amplifiers, annunciators, printers, video display terminals, color graphic displays, transponders and the main CPU locations. Raceways shall be shown, marked for size, conductor count with type and size, showing the percentage of allowable National Electric Code fill used. Drawings shall indicate ambient sound levels used by the system installer for sound level calculations and mathematical justification for signal placement to meet the code required 15dBA above ambient for audible warning signals.
   b. Wiring diagrams showing points of connection and terminals used for all electrical connections to the system devices and panels.
   c. Show actual run of circuit on submittal. “French-curves” will not be acceptable.

6. A complete proposed system database including a description of all logic strings, control by event programming and point identification labels in digital form and in a formatted printed form, as required for offsite editing, uploading and downloading shall be submitted.
for evaluation by the owner. A programming manual shall accompany the submitted program and shall be adequate to allow understanding, operation and editing by the system owner.

7. Statements shall be included, with copies of required licensing, verifying the qualifications of the installer as specified.

8. The fire alarm system subcontractor or manufacturer shall offer, for the owner’s consideration at the time of system submittal, a priced inspection, maintenance, testing and repair contract in full compliance with the requirements of NFPA 72.

B. For use in system test, a complete operation and maintenance manual with two sets of proposed installation drawings shall be submitted.

1. The following information shall be inscribed on the cover:
   a. "OPERATION AND MAINTENANCE MANUAL"
   b. Building location.
   c. The name of the contractor, system manufacturer and system subcontractor.
   d. The name and phone number of the fire department required to respond to alarms at the project location.

2. The manual shall be legible and easily read with large drawings folded and contained in pockets. Included in the manual shall be circuit drawings, wiring and control diagrams with data to explain detailed operation and control of each item of equipment and a control sequence describing start up instructions. Included shall be installation instructions, maintenance instructions, safety precautions, test procedures, performance data, and software documentation.

C. Upon completion of the installation, record drawings shall be submitted on each system before final acceptance of the work. The contractor shall furnish to the Owner a set of record drawings including system diagrams for each system. Refer to Division 1 for submittal requirements.

D. Complete and submit to the Owner a Certificate of Compliance in accordance with NFPA 72.

1.7 SYSTEM FUNCTION

A. The system shall be a complete, electrically supervised multiplex style fire detection and voice evacuation system with intelligent analog alarm initiation, to be device addressable and annunciated as described.

1. The maximum number of devices on a single signaling circuit shall not exceed 50, in order to avoid catastrophic loss of device communications in the event of a raceway destruction, with a capacity of 50 reporting system inputs and 50 system control outputs.

Systems capable of serving in excess of 50 devices to be addressed on as single analog communications network shall be wired and controlled in a Class A configuration including isolation circuitry limiting any short circuit fault to a maximum of 50 addresses and/or a single smoke zone, whichever is less. Device wiring in the Class A configuration shall be installed in a manner eliminating the possibility of exiting wiring sharing the same raceway as the entry wiring for any device.

a. Devices attached to the signaling circuit shall be individually identifiable at the control panel for alarm and trouble indication. Smoke detectors shall be interrogated for sensitivity settings from the control panel, logged for sensitivity changes indicating the requirement for cleaning, and tested by a single technician using the panel field test routine.

b. Sensitivity settings of individual detectors shall be automatically or manually adjustable from the control panel to reduce the incidence of false alarms caused by environmental conditions.

c. The analog signaling circuits shall be installed in the fire alarm control panel enclosure or in remote circuit interface panel enclosures.
The system shall support intelligent analog smoke detection, manual station, water flow, supervisory, security, and status monitoring devices. Fire alarm, supervisory, trouble, security and status shall each be treated as a separate level of alarm, each with its own level of priority. The system shall also support amplifiers and voice/visual circuits.

The panel shall be UL listed as a test instrument for the measurement and logging of the sensitivity of connected intelligent analog ionization and photoelectric smoke detectors connected to the control panel or any remote circuit interface panel to comply with the bi-annual sensitivity logging requirements of NFPA 72.

The measurements shall be discrete voltage readings, accurate to .01 VDC. The readings shall be dynamic, providing a constant display of voltage shifts of the device being tested when in the sensitivity voltage list mode.

The control panel shall provide a display and a printed list of these sensitivity measurements as a permanent record of the required sensitivity testing. An output shall be provided, together with a desktop computer based utility program to allow the data acquired in the sensitivity testing mode to be downloaded into a laptop computer and utilized in a data base program to formulate a complete system history.

When programmed, any system connected light refraction style smoke detector shall be capable of self adjustment to compensate for the accumulation of contaminate that would change the detector sensitivity in either a more or less sensitive direction. This adjustment shall keep the relationship between the sensing chamber voltage and the programmed alarm threshold voltage constant to prevent false indications or failure to alarm in the presence of smoke. Data contained in a memory bank on each detector so programmed, shall maintain an average of the chamber voltage in determining the threshold setting for the device. The threshold setting installed in memory within each device shall maintain programmed operation in all cases, including default and default alarm modes. All devices programmed with this feature shall be automatically tested by the control panel once every twenty four hours to assure their ability to detect and report an alarm condition. This test shall be done as a background routine and shall remain transparent to the user. In the event of a test failure, the control panel shall report a trouble message for the failed device.

Trouble messages displayed by the system LCD displays and logged to system printers and memory shall be programmed with a custom label as selected by the owner to identify the origin by cabinet, room number or other information meaningful to assist maintenance employees.

The system shall annunciate a pre-clean trouble condition when any smoke detector reaches 80% of the allowable threshold movement within the prescribed UL window due to gradual contamination, signaling the need for service, and eliminating unwanted alarms. Upon reaching 100% of the allowable movement, a second "Detector Dirty" message with a trouble condition shall be displayed.

The trouble report shall annunciate the specific location of the smoke detector requiring service. All analog smoke detectors installed in the system shall include this feature.

Upon completion of the cleaning of the device, the system shall reestablish the average chamber voltage file, determining if the detector sensitivity falls within the required window, and display a "Detector Cleaned" message. The detector cleaning shall be logged to the system history file.

Any intelligent analog smoke detector shall include a selectable alarm verification capability. This feature shall provide automatic verification of smoke detector alarms as described by NFPA 72. The system shall have the capability of logging to historical memory, the time and date of all unverified alarm events in order to track activity and generate reports indicating maintenance requirements prior to failures within the system.
6. All external circuits shall be listed as power limited circuits per the National Electric Code. Power limitation shall be provided using on board, self restoring solid state thermal devices. Units using fuses or manually restorable circuit breakers for this purpose or requiring board replacement or exchange will not be acceptable.

7. The system shall recognize initiating of an alarm and indicate the alarm condition in a degraded mode of operation, in the event of processor failure or the loss of system communications to the circuit interface panels.
   a. Each circuit interface panel shall be capable of operation in its own degrade mode. In this mode, the system shall receive an alarm from any intelligent analog or conventional initiating device. It shall activate local indicating appliances and remote or auxiliary connect circuits.
   b. The system shall indicate a trouble condition during degrade mode operation and shall give a visual indication of an alarm condition.
   c. Detector operation in the degrade mode shall continue at the alarm threshold previously programmed. Systems returning detectors to a common default value in degrade mode shall not be acceptable.

8. The system shall provide a default operation program to allow reporting of alarms from installed devices before loading of custom system software.

9. The system shall report alarms from installed devices but not yet added to the system custom program. Alarm reports from these devices shall activate indicating appliance circuits.

10. The system shall perform time based control functions including automatic changes of specified smoke detector sensitivity settings. Time based functions shall be controlled by specifying time periods or actual dates. It also shall provide the ability to control these functions on an exception basis using a holiday schedule.

11. The system shall provide a one person field test initiated from the control panel of either the complete system or a specified area supported from either the master control panel or any remote circuit interface panel, maintaining full function of areas not under test.
   a. Field test shall be usable in a silent or audible mode. When in the audible mode, the signals shall audibly annunciate alarms, troubles and device types, each in a way identifiable by the testing technician.
   b. All field test activity shall be logged to historical memory. It shall be possible to download historic memory to a data base program prior to, and subsequent to the walk test in order to establish a continuous system history. Historic memory shall accommodate a minimum of 800 events to prevent overflow during testing.

12. The system shall be provided with eight levels of password protection with up to forty passwords. In addition the system shall provide for up to sixty four password protected sublevels protecting functions or groups of functions under operator control. Passwords and functions shall be field programmable.

13. The system shall be programmed in the field via a laptop computer. All programmed information shall be stored in nonvolatile memory after loading into the control panel. No special programming terminal or prom burning shall be required and the system shall continue in service during reprogramming. Systems requiring on line terminal programming or not capable of mass reading of panel software for ofsite documentation or editing will not be considered acceptable.
   a. During program reading or loading, the system shall retain the capability for alarm reporting.
   b. The system shall read to a PC for program editing. System program shall be stored in digital format and all programming shall be multilevel password protected.
   c. A U.L. recognized programming utility shall be furnished to compare all altered functions, and input or output addresses, listing all related functions, inputs and output addresses that are affected by the program changes. These items shall constitute a minimum for required certification re-testing of the system in addition to the system device percentage mandated by the codes. Systems not providing this
utility shall not be acceptable due to the expense related to complete re-testing for re-certification after program changes.

14. The system shall consist of a central or distributed multiplex architecture using a centrally located control unit with interconnection to remote circuit interface panels containing any combination of pluggable intelligent analog signaling circuits and plug in relays.
   a. The remote circuit interface panels shall as a minimum, provide a power supply, microprocessor controlled bus structure, battery and automatic charger, and communication link to the main CPU through a high speed 19.2K baud RS-485 network.
      1) The high speed communications network shall be capable of Class A configuration, and when wired in this configuration, both outgoing and incoming paths shall be used for system activity as a means of assuring system response in the event of a loss of wiring continuity.
      2) The high speed communications network shall support the use of fiber optics transmission techniques for the elimination of all electrostatic and electromagnetic induced electrical interference configured as a star loop.
   b. The network communications format shall include error checking of the installation location of each module address to verify the agreement between programmed software and installed hardware as a protection against card installation in incorrect plug in slots. Module printed circuit cards shall be configured within each cabinet to physically prevent the installation of a card in an incorrect slot in that cabinet.

15. The system shall support a UL listed supervised printer at any designated alpha-numeric annunciator.

16. The system shall provide status indicators and control switches for all of the following functions:
   a. Audible and visual evacuation alarm circuit zone control.
   b. Status indicators for sprinkling system waterflow and valve supervisory devices.

17. The system as installed shall be expandable to its predetermined maximum capacity of 200 initiation devices and/or 200 combined zones of speakers, and visual devices using installed software, with no chip changes or additions required for expansion.

18. The system shall be listed by the UL for configuration as an approved NFPA 13 fire suppression system deluge and pre-action releasing system.

1.8 SYSTEM ZONING

A. Each intelligent addressable device on the system shall be displayed at the fire alarm control panel by a unique alpha numeric label identifying its location.

1.9 SYSTEM OPERATION

A. Activation of any fire alarm initiating device shall cause the following actions and indications, unless otherwise noted below:
   1. Display a custom message, describing the device originating the alarm condition at the main fire alarm control panel and remote annunciator.
   2. Report to a central monitoring station via a U.L. listed system. Provisions for fiber connectivity and a dialer shall both be provided.
   3. Sound an alarm tone for a minimum of 2 cycles proceeding and following an automatic digital voice message over all alarm circuits. At the end of the voice message, the alarm tone shall resume. The audio alarm signals shall sound alternately until the signal silence switch is operated.
      a. All audio operations (speaker circuit selection and alarm tone/voice messages and timing variations) shall be activated by the system software, so that future changes can be implemented without rewiring or hardware additions. Audible signals shall
be silenceable from the fire alarm control panel by an alarm silence switch. The alarm indication shall be transferred to a visual indicator on the control panel and the alarm signals shall resound for a subsequent alarm condition, reported by a different device. Visual signals shall be programmable to flash until system reset or alarm silencing. All notification devices shall be deactivated simultaneously per NFPA 72 24.4.2.9.2.

b. A signal dedicated to sprinkler system water flow alarm shall not be silenced while the sprinkler system is flowing at a rate of flow greater than or equal to a single head.

c. Status lights next to speaker selection switches on the control panel shall indicate which of the three messages each speaker circuit is distributing.

d. Provisions for total building paging shall be accomplished by an 'All circuits switch'.

4. Record within the non-volatile system historical memory, the occurrence of the event, the time and date of occurrence and the device initiating the event. In addition, all operator actions shall be logged to system history with time and date.

5. Activation of an AHU duct detector shall shutdown that AHU only and shall not sound a general alarm.

B. Activation of any alarm verified smoke detector in a single elevator lobby or an elevator equipment room shall, in addition to the actions described in 1.9A above, cause the recall of that bank of elevators to the terminal floor and the lockout of controls. In the event of recall initiation by a detector in the terminal floor lobby, the recall shall be to the alternate floor. Activation of any heat detector in the elevator machine room/pit shall activate the elevator recall in accordance with NFPA 72 section 21.3.7.

C. Activation of any air duct detectors shall shutdown that unit and provide supervisory signal only; no alarm condition.

D. Activation of any supervisory circuit; i.e., supervised valve closure, air pressure abnormal, low temperature, fire pump trouble shall cause the following actions and indications:

1. Display the origin of the supervisory condition report at the main fire alarm panel and remote annunciator alphanumeric LCD display.

2. Activate supervisory audible and visual signals. Audible signals shall be silenced from the fire alarm control panel by an alarm acknowledge switch. The supervisory indication shall be transferred to a visual indicator on the control panel and the supervisory signals shall resound for a subsequent supervisory condition, reported by a different device.

3. Record within system history the occurrence of the event, the time of occurrence and the device initiating the event.

E. Receipt of a trouble report; i.e., primary power loss, open or grounded initiating or signaling circuit wiring, open, grounded or shorted indication system wiring, device communication failure, battery disconnect at the fire alarm control panel shall cause the following actions and alarms.

1. Display at the main fire alarm panel and remote annunciator alphanumeric LCD display, the origin of the trouble condition report.

2. Activate trouble audible and visual signals at the control panel.

a. Audible signals shall be silenced from the fire alarm control panel and remote annunciator by a trouble acknowledge switch. The trouble indication shall be transferred to a visual indicator on the control panel and the trouble signals shall resound for a subsequent trouble condition reported by a different device.

b. Trouble conditions which have been restored to normal shall be automatically removed from the trouble display queue and not require operator intervention. This feature shall be software selectable and shall not preclude the logging of trouble events to the historical file.

3. Record within system history, the occurrence of the event, the time of occurrence and the device initiating the event.
1.10 SECURITY SYSTEM INTERFACE

A. Automatic Unlock of Electric Locking Mechanisms.
   1. Fail-safe security electric locking mechanisms as indicated on the security plans shall be automatically unlocked by the security system upon a fire alarm condition.
   2. To provide for automatic unlocking, the fire alarm contractor shall provide a normally closed auxiliary dry output contact from the fire alarm system. Upon a fire alarm condition the contact shall open and the security system shall unlock the electric locking mechanisms. The contact shall remain open until the fire alarm system is manually reset.

   1. Security electric locking mechanisms as indicated on the security plans shall be manually unlocked from a switch at the main fire alarm control panel.
   2. To provide for manual unlocking the fire alarm contractor shall provide a toggle switch in the main fire alarm control panel. Upon activation of the switch a normally closed dry contact shall open and the security system shall unlock the electric locking mechanisms. The contact shall remain open until the switch is returned to the locked position.
   3. The fire alarm contractor shall provide an additional normally closed dry contact from the switch for security system monitoring of the position status of the switch.

C. Automatic Bypass of Card Reader Control of Elevators.
   1. The card reader control of elevators shall be automatically bypassed by the security system upon a fire alarm condition.
   2. To provide for automatic bypass the fire alarm contractor shall provide a normally closed dry output contact from the fire alarm system. Upon a fire alarm condition the contact shall open and the security system shall bypass the card reader control of elevators. The contact shall remain open until the fire alarm system is manually reset.

D. Submittal.
   1. Submit product specifications, fabrication shop drawing, and wiring diagrams for the following:
      a. Interface terminal box
      b. Manual unlock switch

PART 2 - PRODUCTS

2.1 FIRE ALARM CONTROL PANEL

A. Fire alarm control pane is existing to remain.

B. Manufacturer: Notifier.

2.2 FIRE ALARM SYSTEM POWER SUPPLIES

A. System primary power. Primary power for the FACP and the secondary power battery chargers shall each be obtained from the nearest 120V emergency panel. Field verify exact location of the 120V power panel.

B. Secondary power supply. Provide sealed gelled electrolyte batteries as the secondary power supply for the fire alarm control panel and each system circuit interface panel. The battery supply shall be calculated to operate its load in a supervisory mode for 24 hours with no primary power.
power applied and, after that time, operate its alarm mode for 15 min. Batteries shall be sized at no larger than 80% of the calculated size to compensate for deterioration and aging during the battery life cycle. Battery calculations shall be submitted to justify the battery size. Batteries shall be housed in the control cabinet or a separate cabinet with adequate cell separation to prevent accidental discharge.

2.3 REMOTE CIRCUIT INTERFACE PANELS

A. Remote circuit interface panels shall consist of an enclosure, a remote power supply, digital communications circuitry, motherboards, batteries and hardware, modules and circuitry described for inclusion in the fire alarm control panel as required to function as specified.
   1. Circuit interface panels, when required, include conventional zone module, analog loop drivers, indicating appliance circuits, output circuitry to perform actions, speaker supervisory and distribution circuits. All fire detection, alarm and indicating devices supported by the circuit interface panel shall function as a self standing system in the failsafe mode upon loss of the central fire alarm control panel processing, communications or the communications wiring between them.
   2. Smoke detectors shall alarm at their programmed sensitivity settings and shall not revert to a common default setting when their operating system segment is in the default mode.
   3. Circuit interface panels shall support remote system displays, annunciators and printers. Test procedures shall be capable of initiation at the main fire control panel, any remote LCD annunciator or any remote interface panel equipped with a keypad.

2.4 DETECTOR BASES

A. Detector Bases – Detector bases shall be low profile, surface or flush mounted in a standard 4” square by 2-1/8” deep box. Bases shall be able to accept photoelectric, ionization or heat detectors.

2.5 SMOKE DETECTORS-PHOTOELECTRIC

A. Furnish and install intelligent analog smoke detectors with features and characteristics as follows:
   1. Have an LED that flashed during normal operation.
   2. Be self adjusting for airborne contaminants.
   3. Have clear, distinct visual alarm indication.
   4. Be programmed to have alarm verification.

2.6 DUCT DETECTORS-PHOTOELECTRIC

A. Furnish and install intelligent analog duct detectors with features and characteristics as follows:
   1. Report to fire alarm panel as a supervisory alarm.
   2. Have clear, distinct visual power and alarm indications.
   3. Be programmed to have alarm verification.
   4. Have extended visual indicators if mounted above ceiling located as close to duct detector as possible.
   5. Install duct detectors in all supply and return ductwork/plenums. The exact quantity and location of detectors shall depend upon ductwork layout, size, installation etc. In general, a duct detector shall be located in a straight section of the supply air ductwork, a minimum of six duct widths downstream of the unit. If a minimum of six duct widths is not
possible, a duct detector shall be located downstream of the main ductwork, in each section of ductwork that branches off from the main ductwork. For multi zone units the same rules apply and a duct detector shall be located in each duct section exiting the air handling unit. The exact location and quantity of duct detectors shall be based on the final installed ductwork configuration.

2.7 HEAT DETECTORS, INTELLIGENT RATE COMPENSATED

A. Furnish and install heat detectors with features and characteristics as follows:
   1. Shall be of the dual element, self restoring type.
   2. Have a flashing LED for normal operation.
   3. Have clear, distinct alarm visual indication.
   4. The detectors furnished shall have a listed spacing for coverage up to 2,500 square feet for use in environments as covered by Factory Mutual and UL (UQGS) and shall be installed according to the requirements of NFPA 72 for open area coverage.

2.8 MANUAL STATIONS, INTELLIGENT

A. Provide double action intelligent manual stations to be flush or surface mounted as required.
   1. Shall be high impact plastic, red in color.
   2. Provide a clear indication when activated.
   3. Station shall be equipped with terminal strip and pressure style screw terminals for the connection of field wiring.
   4. The manual stations shall be addressable and identifiable by the master fire alarm control panel. Address assignments shall be set electronically and reside within the station in non-volatile memory.
   5. Surface mounted stations shall be mounted using a manufacturer's prescribed matching baked red enamel outlet box.
   6. Provide plastic stopper cover.

2.9 MAGNETIC HOLD OPEN DEVICE

A. Provide 120VAC magnetic hold open devices where indicated on plans and where required by Code. Devices shall close on an alarm.

2.10 INTELLIGENT SYSTEM INTERFACE MODULE

A. Furnish and install, for the monitoring of contact type initiation devices and for the control of electrical devices where required, intelligent analog signaling circuit interface module. Modules shall be supplied to meet the project requirements as follows:
   1. A single circuit intelligent signaling circuit interface module for monitoring alarm, trouble, supervisory security or status contact type devices.
   2. Unit as above with form C software programmable control contacts for the management of specified electrical loads as required by this specification.

B. The module shall be addressed, tested and programmed prior to installation using a UL listed programmer/tester.
C. The module shall be suitable for two wire, two way communications on the intelligent analog signaling circuit. The module shall display a steady LED for each circuit, in the normal power or standby power condition, when in the alarm state or during control circuit activation.

D. Modules shall incorporate triple technology microprocessor chips including analog, digital and EEROM technologies on the single device. Address assignments shall be set electronically.

2.11 FIRE SPRINKLER SYSTEM DETECTION AND SUPERVISION

A. Furnish sensors for installation by the fire sprinkler system contractor and provide system interconnection for the following functions.
   1. Waterflow switches, vane type, with adjustable pneumatic retard of 0 - 75 seconds, single pole double throw switch calibrated for actuation when flow rate equals 10 GPM or greater.
   2. Outside screw and yoke valve supervisory switches in sizes as required for monitoring valves. The single pole double throw supervisory switch shall activate an off normal report within one half turn of the valve.

2.12 INTELLIGENT SUPERVISED CONTROL MODULE

A. Furnish and install for the control of supervised relays, contactors, audible signal circuits, visual signal circuits, distributed speaker circuits, intelligent supervisory and control modules including features as follows:
   1. The modules shall be suitable for two wire operation and communications on intelligent analog alarm detection loops. Address assignments shall be accomplished electronically.
   2. The module shall display a steady LED in the normal power or standby power condition, when in the activated state.
   3. The module shall be suitable for semi-flush or surface mounting in a 2" deep, 4" square or double gang electrical outlet box having a depth of 3 1/2".

B. Modules shall be available to supervise reverse polarity supervised indicating circuits utilizing 24VDC or audio circuits utilizing 25VRMS or 70.7VRMS. It shall be possible to configure the module for control of motor contractors and AC voltages to 115VAC.
   1. All connected field wiring shall be supervised for opens, short circuits and grounded circuits.
   2. All controlled circuits shall be power limited at 1.5A, produced by self-restoring thermal components. Units requiring circuit replacement for restoration of outputs are not acceptable.
      a. Signal outputs shall be supported in either Class B or Class X configuration.
      b. The module shall report a trouble condition in the event of loss of the 24VDC signal operating supply voltage.

2.13 EVACUATION SIGNALS

A. Speakers: Shall be of the polarized 24-Vdc type. Speaker shall be UL listed for fire alarm voice evacuation use. Speakers shall be designed to be mounted on a wall, ceiling or other suitable rigid surface and shall be capable of being surface, semi flush, or flush mounted. Speakers shall be multi-tap. Settings shall be 1/16, 1/8, 1/4, 1/2, 1, 2 or 4 watts.

B. Strobe Light: ADA visual notification appliances shall be compromised of a xenon flashtube and be entirely solid state. These devices shall be UL listed and be capable of either ceiling or wall mounting. Provide a unit that is ADA compliant with an output no less than 15 candela. The
Lexan lens shall be pyramidal in shape to allow better visibility. Provide a red lens on selected strobes where indicated on plans. Strobe light candela ratings have been shown on the plans. However, contractor is responsible for sizing strobes per NFPA 72 based on room size and device location. Units shall be installed 80” above finished floor. All strobes within the same line of site shall be synchronized. Candela ratings have been shown on the plans. These ratings shall be verified based on the room size and NFPA requirements. Where there are discrepancies The NFPA requirements for candela rating shall take precedence over the values shown on the plans. Provide multi-tap strobes to allow for a full range of candela settings. Settings shall be 15/75, 30/75, 75 or 110 candela. Circuits for strobes shall allow for capacity to increase strobe intensities one setting for all strobes. Provide spare devices equal to 1% of the total number of new devices provided for this project.

C. Speaker/Strobe combination: Standard, ADA Audio/Visual units shall provide a common enclosure for the fire alarm audible and visual alarm devices. The housing shall be designed to accommodate either horns, bells, chimes or speakers. The unit shall be complete with a tamper resistant, Pyramidal shaped lexan lens with Fire lettering visible from a 180-degree field of view. The front panel or bezel that is constructed of UL Listed Noryl, may be inverted so that the lens is below the audible device. Integral Xenon strobe shall provide 8000 peak candlepower and be adjustable from 1 to 3 flashes per second. Provide a unit approved for ADA compliance. Strobe shall be multi-tap type to allow for a full range of candela settings as indicated in paragraph G. Xenon strobe shall provide 4-wire connection to insure properly supervised in/out system connection. Unit shall be complete with all mounting hardware including backbox. Audio/visual unit shall be UL listed for its intended purpose. Speaker shall be mulit-tap type to allow for different audio settings as indicated in paragraph F. Provide spare devices equal to 1% of the total number of new devices provided for this project.

D. The evacuation signals shall be available in flush, semi-flush, or surface versions as required for signal locations shown on the contract documents. Signals shall be mounted using a listed outlet box, and as required, tile bridges. Signals shall be available in visual only and combination to satisfy all required project applications. Visual only and combination audio/visual alarms shall be white with red identification lettering. Identification lettering shall be confirmed by owner.

E. Animal Holding Areas:
   1. Provide Silentone sounders, or approved equal, for audible notification in animal holding areas.
   2. Tone shall have an output of 97dB at 450mm and a frequency between 430 and 470Hz.
   3. Verify placement with the Fire Marshal.

2.14 SECURITY INTERFACE TERMINAL BOX

A. The interface terminal box shall be a lockable continuous hinge cover NEMA Type 4 enclosure. The cover of the enclosure shall be labeled to identify its function.

B. Dual screw barrier type terminal strips shall be provided within the interface terminal box. Terminals shall be provided for each interface output from the fire alarm system and the manual unlock keyswitch. All terminals shall be labeled to identify their function.

C. The output contacts from the fire alarm system shall be rated for 1A at 120V.

2.15 MANUAL UNLOCK SWITCH FOR SECURITY SYSTEM

A. The manual unlock switch shall be a maintained DPDT contact toggle switch. The contacts shall be rated for 1 A at 120V.
B. The switch shall be mounted on a single gang plate with a guard to prevent the switch from inadvertently being activated.

C. The switch shall be labeled to identify its function, the locked position, and the unlocked position.

PART 3 - EXECUTION

3.1 DESIGN AND INSTALLATION DRAWINGS

A. Show a general layout of the complete system including equipment arrangement. It shall be the responsibility of the fire alarm contractor to verify dimensions and assure compatibility with all other systems interfacing with the fire alarm system.

1. Identify on the drawings, conduit and conductor sizes and types with number of conductors in each conduit. Provide each conduit and device with a unique identification. For addressable alarm initiation devices, the system identifier shall be the system address for that device. Signals shall be sequentially numbered as the address of the controlling module.

2. Indicate on the point to point wiring diagrams, interconnecting wiring within the panel between modules, and connecting wiring to the field device terminals.

3. Provide mounting details of FACP and other boxes to building structure, showing fastener type, sizes, material and embedded depth where applicable.

3.2 INSTALLATION

A. Perform work in accordance with the requirements of NEC, NFPA 70, and NFPA 72.

B. Fasten equipment to structural members of building or metal supports attached to structure, or to concrete surfaces.

1. Use clamping devices for attaching to structural steel, or when clamping is impractical, obtain written authority to weld or to drill.

2. Fasten equipment to concrete or masonry with expansion anchors.

3. Fasten equipment to drywall by screws into studs, and to metal wall panels by weld studs, bolts or self tapping metal screws.

4. Do not install conduit raceways and boxes in positions that interfere with the work of other trades.

5. Attach nameplates on panels or other components as specified.

6. Heat detectors shall be mounted within two feet of sprinkler heads. Set heat detectors for 135 degree activation.

7. Smoke detectors shall be installed no closer than 3 feet to a supply air grill.

3.3 CONDUIT

A. All wiring shall be installed in conduit. Minimum conduit size shall be 3/4 inch.

3.4 BOXES, ENCLOSURES AND WIRING DEVICES

A. Boxes shall be installed plumb and firmly in position.

1. Extension rings with blank covers shall be installed on junction boxes where required.

2. Junction boxes served by concealed conduit shall be flush mounted
3. Upon initial installation, all wiring outlets, junction, pull and outlet boxes shall have dust covers installed. Dust covers shall not be removed until wiring installation when permanent dust covers or devices are installed.

4. "Fire alarm system" decal or silk-screened label shall be applied to all junction box covers. All boxes shall be red.

3.5 CONDUCTORS

A. Each conductor shall be identified as shown on the shop drawings with wire markers at every splice and terminal point. Attach permanent wire markers within 2 inches of each wire termination. Marker legends shall be visible.

1. All wiring shall be supplied and installed in compliance with the requirements of the National Electric Code, NFPA 70, Article 760, and that of the manufacturer.

2. Wiring for analog loop circuits and speaker circuits shall be 18 AWG twisted. Wiring for strobe circuits shall be a minimum 14 AWG.

3. Splices shall be made using solderless connectors. All connectors shall be installed in conformance with the manufacturer's recommendations.

4. Crimp-on type spade lugs shall be used for terminations of stranded conductors to binder screw or stud type terminals. Spade lugs shall have upset legs and insulation sleeves sized for the conductors.

B. Permanently label or mark each conductor at both ends with permanent alphanumeric wire markers.

C. Provide Type CI, 2 hour rated circuit integrity cable or type MI cable where required per code.

D. All wiring shall be installed in conduit.

3.6 CERTIFICATE OF COMPLIANCE

A. Complete and submit to the Owner in accordance with NFPA 72.

3.7 FIELD QUALITY CONTROL

A. Testing, General.

1. All intelligent analog devices shall be tested and logged for correct address and sensitivity using test equipment specifically designed for that purpose. These devices and their bases shall be tagged with adhesive tags located in an area not visible when installed, showing the system address, initials of the installing technician and date.

2. Wiring runs shall be tested for continuity, short circuits and grounds before system is energized. Resistance, current and voltage readings shall be made as work progresses.

   a. A systematic record shall be maintained of all readings using schedules or charts of tests and measurements. Areas shall be provided on the logging form for readings, dates and witnesses.

   b. The acceptance inspector shall be notified before the start of the required tests. All items found at variance with the drawings or this specification during testing or inspection by the acceptance inspector, shall be corrected.

   c. Test reports shall be delivered to the acceptance inspector as completed.

3. All test equipment, instruments, tools and labor required to conduct the system tests shall be made available by the installing contractor. The following equipment shall be a minimum for conducting the tests:
a. Ladders and scaffolds as required to access all installed equipment.
b. Multimeter for reading voltage, current and resistance.
c. Intelligent device programmer/tester.
d. Laptop computer with programming software for any required program revisions.
e. Two way radios, flashlights, smoke generation devices and supplies.
f. Spare printer paper.
g. A manufacturer recommended device for measuring air flow through air duct smoke detector sampling assemblies.
h. Decibel meter.

4. In addition to the testing specified to be performed by the installing contractor, the installation shall be subject to test by the acceptance inspector.

5. System wiring: fire alarm circuits shall be tested for continuity, grounds, and short circuits.

B. Acceptance testing.

1. A written acceptance test procedure (ATP) for testing the fire alarm system components and installation will be prepared by the Acceptance Inspector in accordance with NFPA 72, and this specification. The contractor shall be responsible for the performance of the ATP, demonstrating the function of the system and verifying the correct operation of all system components, circuits, and programming.

2. A program matrix shall be prepared by the installing contractor referencing each alarm input to every output function affected as a result of an alarm condition on that input. In the case of outputs programmed using more complex logic functions involving "any", "or", "not", "count", "time", and "timer" statements; the complete output equation shall be referenced in the matrix.

3. A complete listing of all device labels for alpha numeric annunciator displays and logging printers shall be prepared by the installing contractor prior to the ATP.

4. The acceptance inspector shall use the system record drawings in combination with the documents specified under Paragraph 3.1 during the testing procedure to verify operation as programmed. In conducting the ATP, the acceptance inspector shall request demonstration of any or all input and output functions. The items tested shall include but not be limited to the following:
   a. System wiring shall be tested to demonstrate correct system response and correct subsequent system operation in the event of:
      1) Open, shorted and grounded intelligent analog signaling circuit.
      2) Open, shorted and grounded network signaling circuit.
      3) Open, shorted and grounded conventional zone circuits.
      4) Open, shorted and grounded speaker circuits.
      5) Intelligent device removal.
      6) Primary power or battery disconnected.
      7) Incorrect device at address.
   b. System evacuation alarm indicating appliances shall be demonstrated as follows:
      1) All alarm notification appliances actuate as programmed
      2) Audibility and visibility at required levels.
   c. System indications shall be demonstrated as follows:
      1) Correct message display for each alarm input at the control panel and each remote alphanumeric display.
      2) Correct annunciator light for each alarm input at each annunciator and color graphic terminal as shown on the drawings.
      3) Correct printer logging for all system activity.
   d. Secondary power capabilities shall be demonstrated as follows:
      1) System primary power shall be disconnected for a period of time as specified herein. At the end of that period, an alarm condition shall be created and the system shall perform as specified for a period as specified.
2) System primary power shall be restored for forty-eight hours and system charging current shall be normal trickle charge for a fully charged battery bank.

3) System battery voltages and charging currents shall be checked at the fire alarm control panel using the test codes and displayed on the LCD display.

5. In the event of system failure to perform as specified and programmed during the ATP procedure, at the discretion of the acceptance inspector, the test shall be terminated.
   a. The installing contractor shall retest the system, correcting all deficiencies and providing test documentation to the acceptance inspector.
   b. In the event that software changes are required during the ATP, a utility program shall be furnished by the system manufacturer to compare the edited program with the original. This utility shall yield a printed list of the changes and all system functions, inputs and outputs effected by the changes. The items listed by this program shall be the minimum acceptable to be re-tested before calling for resumption of the ATP. The printed list and the printer log of the retesting shall be submitted before scheduling of the ATP.
   c. The acceptance inspector may elect to require the complete ATP to be performed again if, in his opinion, modifications to the system hardware or software warrant complete re-testing.

3.8 DOCUMENTATION

A. System documentation shall be furnished to the owner and shall include but not be limited to the following:
   1. System record drawings and wiring details including one set of reproducible masters and drawings on CD ROM or DVD in a DXF format suitable for use in a CAD drafting program.
   2. System operation, installation and maintenance manuals
   3. Written documentation for all logic modules as programmed for system operation with a matrix showing interaction of all input signals with output commands.
   4. Documentation of system voltage, current and resistance readings taken during the installation, testing and ATP phases of the system installation.
   5. System program showing system functions, controls and labeling of equipment and devices. Also provide a digital copy of the system file.

3.9 TEST EQUIPMENT

A. The Contractor shall furnish all test equipment as required to program devices and test the system, specifically an intelligent device tester and programmer.

3.10 INTERFACE TERMINAL BOX

A. The fire alarm system contractor shall install the interface terminal box at the main fire alarm control panel in a readily accessible location no more than 8'-0" A.F.F.

B. The fire alarm contractor shall wire from the fire alarm system to the interface terminal box.

C. The security contractor shall wire from the security system to the interface terminal box.
3.11 MANUAL UNLOCK SWITCH
A. The fire alarm system contractor shall install the manual unlock switch at the main fire alarm control panel in a location approved by the local code officials.
B. The fire alarm contractor shall wire from the manual unlock switch to the interface terminal box.

3.12 INTERFACE CONDUIT, POWER AND WIRING
A. The fire alarm contractor shall provide all conduit, power and wiring required for the installation of the terminal box, manual unlock switch and interfacing to the fire alarm system. All wiring shall be UL listed for the fire alarm applications.
B. The security contractor shall provide all wiring from the interface terminal box to the security system. All wiring shall be UL listed for fire alarm applications.

3.13 WARRANTY AND SERVICES
A. The contractor shall warrant the entire system against mechanical and electrical defects for a minimum of 18 months. This period shall begin upon completed certification and test of the system. Coordinate with Division 1 requirements.
B. During the warranty period, the fire alarm system subcontractor or manufacturer shall provide at no additional charge the inspection, parts, maintenance, testing and repair in full compliance with the requirements of NFPA 72. Response time to any trouble call shall not be more than 2 hours with resolution within 24 hours.
C. The installation contractor shall furnish training as follows for a minimum of four employees of the system user:
   1. Training in the receipt, handling and acknowledgement of alarms.
   2. Training in the system operation including manual control of output functions from the system control panel.
   3. Training in the testing of the system including logging of detector sensitivity, field test of devices and response to common troubles.
   4. The total training requirement shall be a minimum of 6 hours but shall be sufficient to cover all items specified.

END OF SECTION
SECTION 28 1000

ELECTRONIC ACCESS CONTROL AND INTRUSION DETECTION

PART 1 - GENERAL

1.1 SUMMARY/OVERVIEW
A. This section provides specifications for the installation of Electronic Access Control (AC), Intrusion Detection (ID), and related components.

B. Related Sections
1. Section 087100 Door hardware
2. Section 260000 Electrical (including related sub-sections)
3. Section 270000 Communications (including related sub-sections)
4. Section 280000 Electronic Security
5. Section 282300 Video Surveillance
6. Section 282600 Emergency Intercommunications and Duress
7. Section 283100 Fire Alarm and Smoke Detection

1.2 REFERENCES
A. See Section 280000 Electronic Security.

1.3 GENERAL SYSTEM DESCRIPTION
A. The project shall be equipped with a system that is an extension of an existing system maintained by the Owner.
1. All work required within the project for extension of the AC/ID system to the existing system head end shall be furnished and installed by the project security contractor.

B. General Requirements
1. Furnish all labor, materials, tools, equipment, and services for a complete security system as indicated and in accordance with provisions of the contract documents.
2. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, and devices incidental to or necessary for a sound, secure and complete installation.
3. Comply with the provisions of Division 1 for General Requirements.
   a) In the event of a conflict between the provisions of this Section and Division 1, the more stringent provisions shall apply.
4. All system devices and components included shall be compatible.

C. The AC/ID system will support the needs of the project in accordance with these specifications.
1. The AC/ID system shall have the capability for future expansion to support the security needs of the completed complex.

D. Provide an AC/ID/Surveillance computer workstation as indicated on the drawings.
   1. The expanded AC/ID system will be connected via the owner’s Local Area Network (LAN) to control and monitor equipment in the new locations.
   2. The security subcontractor is responsible to coordinate setup and programming to ensure that all systems and alarm points report correctly at the remote location.
   3. Refer to Section 282300 for additional requirements.

E. The AC/ID system shall be interfaced with the Fire Alarm system (by others) as required to comply with all building code requirements.

F. Emergency/UPS power will be utilized to power the AC/ID system’s computer workstation (client) at the Security head end equipment location.

G. Emergency/APS power will be utilized to power the AC/ID system’s Data Gathering Panels and control components as required throughout the facility.

1.4 SYSTEM COORDINATION

A. The Security Integrator shall completely coordinate all relevant work of other trades/systems including, but not limited to:
   1. Door hardware
   2. Fire Alarm System
   3. Electrical Systems(s)
   4. Telecommunications System(s)

B. Electric Locking Mechanisms
   1. The security integrator and door hardware contractor shall coordinate all door hardware, door and door frame design.
   2. The security contractor shall verify all specified door hardware is appropriate for the security application and verify the sequence of operations for each access controlled opening.

C. Fire Alarm and Life Safety
   1. The security integrator shall coordinate the access control system design with the life safety consultant to ensure compliance with applicable codes and requirements.
   2. This includes, but is not limited to:
      a) Fire alarm interface
      b) Fail safe/fail secure locking mechanisms
      c) Delayed egress

1.5 ACCESS CONTROL SYSTEM

A. The AC system will consist of card readers, door position switches, and request-to-exit sensors operating in conjunction with associated electric door hardware.
1. Card readers and adjunct devices shall be provided as shown on the drawings.
   a) Provide card readers, Data Gathering Panels <DGP>, and alarm input and output devices connected to the security management system via Local Area Network (LAN).
   b) The security integrator shall coordinate network and IP address requirements with Owner to identify the Media Access Control (MAC) address (Layer 2) of each provided device, the location to be installed, and the port configuration needed for communication.
   c) Furnish all labor, materials, tools, equipment, and services for a complete system as indicated and in accordance with provisions of the contract documents.
   d) Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, and devices incidental to or necessary for a sound, secure and complete installation.

B. Card readers will work such that upon presentation of a valid AC card, the unique card data shall be transmitted to an associated control panel where the data is compared to an authorized user database and access is approved or rejected accordingly.
   1. A valid authorization will activate operation of the electric lock and shunt the door position switch. The alarm shunt will not affect supervision of the detection circuit.
   2. Coordinate with owner on card format and other pertinent details.

C. Card readers shall support both 125 KHz proximity and 13.56 MHz smart card technologies

D. Card readers shall support Magnetic Stripe, 125 KHz proximity, and 13.56 MHz smart card technologies

E. Card readers shall support 125 KHz proximity technology.

F. Card readers shall support 13.56 MHz smart card technology.

G. Card readers shall support Magnetic Stripe technology.

H. Card readers shall support Open Supervised Device Protocol (OSDP) for secure bidirectional communication.

I. Door position switches at card reader controlled location serve to indicate the open/closed status of the associated door and shall establish the basis for reporting a door-proped or unauthorized entry condition.
   1. Provide door position switches as indicated on drawings.
   2. Flush mounted door position switches are provided by Division 08 contractor as indicated on drawings.
   3. Security contractor is responsible for coordinating the contact configuration (SPDT) (DPDT) and rating for door position switches, and for connection of switches with the AC.

J. Electrified door hardware for card reader controlled doors will include electrified locksets, electric exit devices, and electric power transfer as shown on the drawings.
   1. All electrified door hardware shall be provided under the work of Division 08 unless otherwise noted.
   2. Security subcontractor shall provide security cables/conductors and low voltage power supplies for security system controlled electric door hardware.
K. Request-to-exit (REX) devices at designated card reader controlled doors shall cause the associated door position switches to be shunted.

1. The alarm shunt shall not affect the supervision of the alarm detection circuit.
2. Electrified Lockset shall have an integral REX switch.
3. Electrified Exit devices shall have an integral REX switch.
4. Magnetic Locks shall have a Passive InfraRed (PIR) motion sensor REX device.

   a) Wire the PIR to the Door REX Input. The configuration on this motion shall be non-resettable and activate for only 2 seconds.
   b) A second set of output contacts for the REX motion sensor shall be wired in series with the power to the lock, disconnecting power to the lock when motion is sensed.
   c) The PIR REX shall be mounted and the sensor positioned to avoid detection more than three feet from the door and at the door bottom sweep.

   1) Deter under door spoofing attacks by pointing the sensor away from the door threshold. Position the sensor to detect motion at the door handle or door push plate.

   d) Connect to REX switch in exit device (by Division 8).

      1) Coordinate with Division 8 to ensure proper REX switch configuration
      2) Wire the REX switch as described for the above motion sensor to disconnect power to the lock and activate the REX input on the DGP.

   e) Doors with out exit devices, a UL listed double pole pushbutton exit switch shall be provided as a redundant REX device.

      1) It shall be wired as described for the above motion sensor to disconnect power to the lock and activate the REX input on the DGP.
      2) Locate within 6'-0" of the door push-plate/handle.

L. Remote Door Release Button

1. Designated doors equipped with electric locking devices that can be released from a remote location through the use of a door release push-button.

   a) The momentary push-button shall interface to a DGP auxiliary input to provide momentary lock release and door alarm shunt. Interface will include supervised circuit terminated to normally open DGP input.
   b) Assign the remote door release pushbutton a unique identifier in the access control system database and record door release pushbutton events in the access control system database.

M. Door Management Unit (DMU)

1. Designated door will be equipped with a DMU to sound a local alert when doors are propped open beyond a field programmable time delay.

   a) The DMU audible alert will be a recording prompting people in the area to close the door.
   b) The DMU shall report a door propped alarm to the AC/ID after a field programmable delay. The delay will be sufficient for people in the area to correct the security violation.
c) The DMU shall have a key operated switch to bypass the alarm and report the bypass condition to the AC/ID.

1.6 INTRUSION DETECTION SYSTEM

A. A series of field installed alarm initiating devices shall be connected to the ID system so that status changes of the devices are transmitted to the security management system.

1. Provide Alarm Panels <AP>, alarm devices, and keypads to be connected to the security management system via Local Area Network (LAN).
2. The security integrator shall coordinate network and IP address requirements with Owner to identify the Media Access Control (MAC) address (Layer 2) of each provided device, the location to be installed, and the port configuration needed for communication.

B. Wireless Alarm Receiver

1. Provide wireless alarm receivers to receive wireless device alarms and transmit alarms to AC/ID system monitoring locations.
2. Provide wireless survey to confirm coverage area and quantity of receivers, repeaters, and/or antennas required. Provide adequate quantity of receivers, repeaters, and/or antennas to provide reliable wireless communications with wireless alarm transmitters.
3. Provide full integration of the wireless alarm receiver with the AC/ID system
4. Provide dry contact alarm relay or high level interface to AC/ID alarm panel
5. Provide individual alarm notification for fault, low battery, transmitter missing/out-of-range and all other transmitter/receiver failures.
6. Provide alarm logging.

C. Motion Detector

1. Provide dual technology (microwave and infrared) to prevent false alarms.
   a) Specific model depends on application and mounting requirements.
   b) One motion detector per zone, do not wire in series.

D. Glass Break Detector

1. Contractor will need to provide compatible glass break tester for device being installed.
2. One glass break detector per zone, do not wire in series.

E. Tamper Switches

1. Typically closed tamper switches to monitor the secure status of all DGP’s, power supplies, terminal cabinets, power distribution units, and other Security System cabinets and enclosures.
2. Fasten tamper switches within the cabinet to provide no access to the switch and fasteners when the cabinet is closed.
3. Provide independent monitoring of tamper conditions for each cabinet.
   a) Include the number of tamper switches in the total alarm input figures.

F. Provide ID keypads conveniently located near areas being protected so as to allow devices to arm and disarm.
1.7 SUBMITTALS

A. Follow provisions of Section 280000 additional requirements.

B. Field Test Reports

1. Upon completion and testing of the installed system, test reports shall be submitted in booklet form and electronic media showing all field tests performed on, and adjustments made to each/any component and all field tests performed to prove compliance with the specified performance criteria.

2. Indicate and interpret test results in written form and verbally to owner/DataCom for compliance with performance requirements at a pre-scheduled meeting.

C. Battery calculations to show the expected loads and backup duration for power supplies and UPS devices for all active AC/ID equipment.

D. Security Contractor is responsible to prepare and submit as required to the Authority Having Jurisdiction (AHJ) any and all information to obtain an Electronic Locking Mechanisms permit.

1.8 QUALITY ASSURANCE

A. Follow provisions of Section 280000.

B. Spare Parts:

1. Provide the following spare parts:

   a) One (1) of each type of surface mounted door position sensor
   b) Two (2) concealed door position sensor
   c) One (1) of each type of card reader and card reader/keypad
   d) Access control data gathering panel

      1) One (1) network controller
      2) Two (2) card reader interface board

   e) One (1) door management unit
   f) One (1) local alarm sounder

2. The security integrator will turnover the new and unused components and devices to the owner at project closeout.

1.9 DELIVERY, STORAGE AND HANDLING

A. Follow provisions of Section 280000.

1.10 PROJECT/SITE CONDITIONS

A. Follow provisions of Section 280000.

1.11 WARRANTY
A. Follow provisions of Section 280000.

B. All devices and components shall comply with applicable U.L. standards.

PART 2 - PRODUCTS

2.1 ACCEPTABLE SYSTEM MANUFACTURERS

A. AC System Platform Software
   1. AMAG Symmetry
   2. Owner Approved Equivalent

B. System Platform Server (By Owner)
   1. Dell
   2. Hewlett Packard
   3. IBM
   4. Owner Approved Equivalent

C. Workstation (refer to 282300)

2.2 ACCEPTABLE ACCESS CONTROL MANUFACTURERS

A. Access Control Data Gathering Panels <DGP>
   1. AC/ID System compatible
   2. Owner Approved Equivalent

B. Proximity Card Readers <CR>
   1. HID
   2. XceedID
   3. Owner Approved Equivalent

C. ID credential printer (with card stock and consumables to produce 250 credentials)
   1. Fargo
   2. Nisca
   3. Datacard
   4. Magicard
   5. Owner Approved Equivalent

D. Door Position Switches <DP>
   1. Concealed Magnetic Door Position Switch
      a) George Risk Industries (GRI) 199-12
      b) Sentrol 1076D
      c) Owner Approved Equivalent
2. Surface Mount Door and Hatch Position Switch
   a) GRI 4405-A
   b) Sentrol 2500
   c) Owner Approved Equivalent

3. Overhead Door Position Switch
   a) Floor mounted
      1) GRI 230-36
      2) Sentrol 2200
      3) Owner Approved Equivalent
   b) Track mounted
      1) GRI 4405-A with 8297-Kit Industrial Track Mount
      2) Sentrol 2300
      3) Owner Approved Equivalent

E. Request-to-Exit Motion Sensor
   1. Bosch DS160 series
   2. Kantech T.REX series
   3. Owner Approved Equivalent

F. Door Management Unit (DMU)
   1. DSI ES4600 product family
   2. Owner Approved Equivalent

G. Electric Locking Mechanism Power Supply
   1. Altronix
   2. Alarm-Saf
   3. LifeSafety Power
   4. Owner Approved Equivalent

H. Electric Locking Mechanisms (By Division 08)
   1. Sargent
   2. Schlage
   3. Von Duprin
   4. Locknetics
   5. Owner Approved Equivalent

I. Electric Power Transfer (By Division 08)
   1. Security Door Controls (SDC)
   2. Schlage
   3. Von Duprin
   4. Owner Approved Equivalent

J. Uninterruptible Power Supply <UPS>
1. Eaton UPS
   a) 5S series for workstations
   b) 9170 for rack mounted equipment

2. APC Smart-UPS Series
   a) SMT series for workstations
   b) Smart-UPS on-Line series for rack mounted equipment

3. MinuteMan
   a) Pro series for workstations
   b) Enterprise Plus series for rack mounted equipment

4. Owner Approved Equivalent

K. Wire & Cable
   1. Belden
   2. Windy City
   3. General Cable
   4. Owner Approved Equivalent

2.3 ACCEPTABLE INTRUSION DETECTION MANUFACTURERS

A. ID System Platform
   1. Honeywell
   2. UTC Caddx
   3. Bosch
   4. Tyco
   5. DMP
   6. Owner Approved Equivalent

B. Intrusion Detection Alarm Panels <AP>
   1. AC/ID System compatible
   2. Owner Approved Equivalent

C. Wireless Alarm Receiver
   1. AC/ID System compatible
   2. Owner Approved Equivalent

D. Keypads
   1. AC/ID System compatible
   2. Owner Approved Equivalent

E. Tamper Switches
   1. GRI TS-20 Series
2. Sentrol 3010
3. Owner Approved Equivalent

F. Dual Technology Motion Detectors
   1. AC/ID System compatible
   2. Owner Approved Equivalent

G. Glass Break Detectors
   1. AC/ID System compatible
   2. Owner Approved Equivalent

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Power Supplies
   1. Power supply requirements
      a) A switch and on/off indicator within the power supply cabinet.
      b) Four hours of sealed gel battery backup to provide continuous operation during power failure.
         1) Provide batteries as required to provide specified battery backup time for a fully loaded power supply, regardless of the connected load.
      c) A battery charger to maintain the battery.
      d) Low battery and power fail contacts to monitor the status of the input power and the battery.
         1) Connect each power supply low battery and power fail alarm as a separate alarm input into DGP.
      e) Key lockable wall mount metal enclosure with tamper switch.
   2. Additional DGP Power Supply Requirements
      a) The DGP power supply provides power only to DGP’s and shall not provide power for locks or any other low voltage device.
   3. Additional Electric Locking Mechanism Power Supply Requirements
      a) Fail secure electric locking mechanisms shall remain locked during power failure and fire alarm conditions.
      b) Connect fail safe locking devices in accordance with applicable life safety codes to unlock automatically under the following conditions:
         1) Loss of power to the power supply
         2) Failure of the power supply
         3) Fire alarm activation
c) Provide power distribution boards with independently fused output relays and fire
alarm control panel interface.
d) Provide network communication interface for remote power supply monitoring,
reporting and control.

4. Additional Device Power Supply Requirements

a) Provide device power supplies for other security system devices requiring power
(e.g. card readers, local alarms, motion sensors, etc.)
b) Provide power distribution boards with independently fused outputs.

B. Video Surveillance System Integration

1. Automatic Video Call-up

a) All alarms shall call up all cameras in the area of alarm to the screen of the ACID
alarm operator workstation to allow for operator assessment of the alarm.

2. Pre and Post Alarm Video

a) The operator shall be able to view up to 10 seconds of video before the alarm and
30 seconds after the alarm for all cameras associated with the alarm.
b) This feature is to be integrated with the operator alarm notification to assist in alarm
assessment.
c) This feature shall be displayed as an option on the alarm notification screen and will
not require operator to make a manual video search.

3. Recording

a) All cameras whose field of view that include images of the area affected by the alarm,
shall be recorded when an alarm is detected for use in forensic analysis, including
the pre and post alarm video.

4. Duress and Emergency Intercommunications Integration

a) Calls from emergency intercoms/phones with cameras shall provide the above video
call-up and the pre and post alarm video capabilities.

C. Tamper Resistant Screws

1. Provide appropriate screw heads for each application (e.g. countersunk heads for recessed
cover plate screws, flat head screws for standard junction box covers, etc.).

2. The security integrator shall provide Torx® tamper resistant screws for:

a) Junction boxes located above doors
b) Junction boxes located below ceiling height and/or within reach of hatch ladders
c) Security device cover plates
d) Surface mounted door position switches and armored cable

3.2 ENCLOSURE INSTALLATION

A. Enclosures shall be lockable with a tamper switch and installed in a manner to be accessible with
clearance to fully open enclosure door.
B. All security panels shall be wired through a dedicated power supply with battery backup.
   1. Power to the data gathering panels is to be hardwired utilizing EMT or rigid conduit in accordance with the Electrical specifications.
   2. A circuit from the Fire Alarm panel must be installed to each lock power distribution panel.

C. Enclosures shall be installed on designated wall fields in a neat and compact manner to allow for future growth.

D. Enclosures shall be sized to allow for 20% growth in each panel.

E. All panels and boards shall be installed in enclosure(s) suitable to their environment and have sufficient size and orientation to include all system components.

F. Each panel shall be labeled accordance with Owner standards.
   
   The label for each panel shall be posted on the exterior of the panel door.
   
   a) Each panel shall have a list of devices connected to it located on the inside cover.
   b) A detailed device layout drawing will be located on the inside of the panel door in an appropriate sleeve and keeper.

3.3 FURTHER REQUIREMENTS

A. Refer to provisions of Section 280000.

B. Furnish and coordinate installation of all special device back boxes and ACID field devices as shown on the security drawings and as specified in this section.

C. The exact installation locations of all equipment shall be coordinated and verified with the Contractor prior to installation.
   
   1. Subcontractor shall notify the Contractor if any location appears to be unsuitable.

D. Provide low voltage power supplies for electric locking devices and ACID devices and components as shown on the security drawings and specified in this Section.

E. Coordinate with the Telecommunications Subcontractor for data network connections, IP address requirements, and telephone circuits as required.

F. Prepare all systems for user operation.
   
   1. The security system must be complete and ready to operate prior to Owner final acceptance of the system.

G. Coordinate with the Owner for all system programming requirements.

H. Perform database programming as required to support the card reader, alarm point, surveillance system integration, and control panel configuration as required.
END OF SECTION
SECTION 28 2300
VIDEO SURVEILLANCE

PART 1 - GENERAL

1.1 SUMMARY/OVERVIEW

A. This section provides specifications for the installation of an IP based Video Surveillance System (VS) and related components.

B. Related Sections

1. Section 260000 Electrical (including related sub-sections)
2. Section 270000 Communications (including related sub-sections)
3. Section 280000 Electronic Security
4. Section 281000 Electronic Access Control and Intrusion Detection
5. Section 282600 Duress and Emergency Intercommunications and Duress

1.2 REFERENCES

A. See Section 280000 Electronic Security.

1.3 SYSTEM DESCRIPTION

A. The project will be equipped with a Video Management System (VMS) that is an extension of an existing VMS maintained by the Owner.

1. The new Video Management System (VMS) shall facilitate interface with the existing security head end equipment.
2. All work required to make available an extension to existing equipment shall be furnished and installed by the security subcontractor.
3. The Local Area Network (LAN) shall be used to make available the viewing of live and recorded signals from the local PC based NVR to other locations.

B. The security integrator shall furnish and install the surveillance system, consisting of camera assemblies, NVR, Network Switch, wiring & cabling, and low voltage camera power supplies.

1. All active surveillance equipment and communication devices shall be on emergency/UPS power.

C. Camera assemblies include camera, lens, housing, and mount. Provide and install wiring and low voltage power from the security wall field/rack to the camera locations.

1. Scope of work shall be complete from point of origin (camera) to point of termination (security rack).

D. Provide rack mount 1U monitor/keyboard/track ball drawer with 20” LCD monitor for display and programming, keyboard, track ball, and integrated four-port KVM switch.
1. Provide additional KVM ports as required plus two spare ports if Work includes more than two NVRs.

E. Coordinate all work that must be performed in security head end spaces with the General Contractor, the Electrical Contractor, and the Telecommunications contractor. (if applicable)

F. Camera images shall support H.264 compression formats.

G. Provide NVR with 50% spare storage capacity for future expansion.

H. Camera lenses for fixed cameras shall be varifocal and sized to provide the owner approved field of view. The lens shall be IR corrected and have megapixel resolution.

I. Surveillance camera audio functions shall not be installed and/or disabled unless specifically requested by Owner.

1.4 SUBMITTALS

A. Follow provisions of Section 280000 for additional requirements.

B. Project Data

1. Provide a description of system operation indicating the purpose and capability of each device/component of the system with a functional diagram indicating all interfaces to other systems.

C. Video Quality test reports shall be provided for all cameras to confirm an optimum high definition video signal.

D. Shop drawings shall reflect all requirements associated with Owner provided or existing equipment and materials that will be used as part of this system.

E. Video Storage calculations to show the system capacity can accommodate the specified video retention.

F. Battery calculations to show the expected loads and backup duration for camera power supplies and UPS devices for all active surveillance equipment.

G. System programming, camera titles, descriptions, camera images and database

1. Camera titles and descriptions prior to system programming
2. Programming/database prior to performance testing
3. Provide a cross reference between specified camera numbers and programmed camera numbers
4. Final programming, camera images and system documentation on electronic media to Owner

H. Product Data

1. Manufacturer’s technical data sheets and specifications

1.5 QUALITY ASSURANCE
A. Follow provisions of Section 280000.

B. Spare Parts:
   1. Provide the following spare parts:
      a) One (1) of each type of surveillance camera
   2. The security integrator will turnover the new and unused components and devices to the owner at project closeout.

1.6 DELIVERY, STORAGE AND HANDLING
A. See Section 280000.

1.7 PROJECT/SITE CONDITIONS
A. See Section 280000.

1.8 WARRANTY
A. See Section 280000.

PART 2 - PRODUCTS

2.1 CAMERA SPECIFICATIONS
A. All cameras shall be a Dome Camera unless otherwise specified
   1. Compatible with the VMS
   2. Vandal resistant with polycarbonate dome
   3. Wide Dynamic Range Feature: All exterior cameras and interior cameras that have exterior lighting or headlights in their field of view shall have a Wide Dynamic Range feature to improve picture quality in situations with strong backlighting.
   4. Multi-stream so that recording and viewing can be at different frame rate and compression.
   5. Day-night Color/B&W camera with cut filter
   6. Exterior cameras:
      a) Include a heater to permit fog-free viewing in low temperatures
      b) Fan to prevent overheating in high temperatures (as required)

B. Interior Fixed Dome Camera:
   1. Resolution shall be a minimum of 2MP (1080p) at 30 FPS
   2. Shall be IP, PoE IEEE 802.3af
   3. Smoked lower dome
   4. Include an SD card sized to allow for scheduled and event based storage of images
   5. Varifocal auto-iris fixed lens sized to provide the owner approved field of view
6. Size camera and lens for facial recognition at a minimum of 60 pixels per foot at the target location
7. Shall have a minimum sensitivity of 0.05 Lux at 30 IRE

C. Interior Single Sensor Panoramic 180° and 360° Camera:
   1. Resolution shall be a minimum of 12MP at 20 FPS
   2. Shall be IP, PoE IEEE 802.3af
   3. Smoked lower dome
   4. Include an SD card sized to allow for scheduled and event based storage of images
   5. Native edge processing to allow for multiple views including:
      a) 180° / 360° overview
      b) Up to 4 individually cropped out and de-warped views
   6. Fixed Iris / Fixed Focus
   7. Horizontal/Vertical FoV: min 180°
   8. Size camera and lens for facial recognition at a minimum of 60 pixels per foot at the target location
   9. Shall have a minimum sensitivity of 0.19 Lux at 50 IRE

D. Interior Multi Sensor 180°, 270°, and 360° Camera:
   1. Resolution shall be a minimum of 8MP at 30 FPS (4x 1080p)
   2. Shall be IP, PoE IEEE 802.3af
   3. Smoked lower dome
   4. Include an SD card sized to allow for scheduled and event based storage of images
   5. Allows for up to 4 multiple views
   6. Varifocal auto-iris fixed lens sized to provide the owner approved field of view.
   7. Size camera and lens for facial recognition at a minimum of 60 pixels per foot at the target location
   8. Shall have a minimum sensitivity of 0.17 Lux at 50 IRE

E. Exterior Fixed Dome Camera:
   1. Resolution shall be a minimum of 2MP (1080p) at 30 FPS
   2. Shall be IP, PoE IEEE 802.3af
   3. Clear lower dome, unless otherwise specified
   4. Include an SD card sized to allow for scheduled and event based storage of images
   5. Vari-focal auto-iris fixed lens sized to provide the owner approved field of view.
   6. Outdoor rated to meet International Protection Rating (IP) 66
   7. Shall have a minimum sensitivity of 0.05 Lux at 30 IRE

F. Exterior Single Sensor Panoramic 180° and 360° Camera:
   1. Resolution shall be a minimum of 12MP at 20 FPS
   2. Shall be IP, PoE IEEE 802.3af
   3. Clear lower dome, unless otherwise specified
   4. Include an SD card sized to allow for scheduled and event based storage of images
   5. Native edge processing to allow for multiple views including:
      a) 180° / 360° overview
      b) Up to 4 individually cropped out and de-warped views
6. Fixed Iris / Fixed Focus
7. Horizontal/Vertical FoV: min 180º
8. Size camera and lens for facial recognition at a minimum of 60 pixels per foot at the target location
9. Outdoor rated to meet IP66
10. Shall have a minimum sensitivity of 0.19 Lux at 50 IRE

G. Exterior Multi Sensor 180º, 270º, and 360º Camera:
1. Resolution shall be a minimum of 8MP at 30 FPS (4x 1080p)
2. Shall be IP, PoE IEEE 802.3af
3. Clear lower dome, unless otherwise specified
4. Include an SD card sized to allow for scheduled and event based storage of images
5. Allows for up to 4 multiple views
6. Varifocal auto-iris fixed lens sized to provide the owner approved field of view.
7. Size camera and lens for facial recognition at a minimum of 60 pixels per foot at the target location
8. Outdoor rated to meet IP66
9. Shall have a minimum sensitivity of 0.17 Lux at 50 IRE

H. Interior/Exterior Pan Tilt Zoom (PTZ) Dome Cameras:
1. Resolution shall be a minimum of 2MP (1080p) at 15 FPS
2. Shall be IP, PoE+ IEEE 802.3af
3. Smoke or Clear lower dome as required
4. Include an SD card sized to allow for scheduled and event based storage of images
5. Fixed focus / fixed iris
6. Minimum horizontal FoV: 150º / vertical FoV: 80º
7. One click PTZ control
8. Outdoor rated as required, to meet IP66
9. Shall have a minimum sensitivity of 0.3 Lux

2.2 NETWORK VIDEO RECORDER

A. The Network Video Recorder shall be compatible with the existing video management system along with the following minimal requirements:
1. Hot swappable storage drives in a RAID 5 array
2. Dual hot swappable redundant power supplies
3. Support dual stream cameras
4. Include a dual Network Interface Card (NIC) that supports:
   a) Full duplex
   b) Fault tolerance
   c) Link aggregation
   d) Load Balancing
   e) Traffic prioritization
   f) Hot swap
5. Native support of H.264 compression that does not require the use of additional software or equipment
6. Provide a 20 inch 1080P service monitor and keyboard at each NVR equipment rack
7. Provide video storage capacity for 30 days using the following minimum criteria
a) All cameras using H.264 compression
b) Interior cameras: Use native camera resolution
c) Exterior cameras: Use native camera resolution
d) Wide angle lens cameras: Use native camera resolution
e) Motion triggered recording

1) Assume that motion will be detected 50% of the day
2) Motion detection will be configurable by camera and schedule to mitigate nuisance triggers
3) Record video at 12 FPS when motion is detected
4) Record video at 1 FPS when no motion is detected

B. Coordinate with owner on the number of user licenses required

C. Provide UPS for backup power to the NVR and peripheral equipment

1. Follow provisions of Section 28000 for UPS power requirements
2. Coordinate with Division 26 to provide a dedicated Emergency Power circuit

2.3 WORKSTATION

A. Provide a fully configured high-speed workstation that will deliver acceptable performance with adequate hardware, processing capacity and peripherals to support the VMS, Access Control, Intrusion Detection systems and the owner provided business suite applications.

1. Coordinate with Section 281000 contractor for AC and ID requirements
2. Provide all required VMS application and required VMS administration software
3. Coordinate with owner’s IT department

a) Workstation IP address
b) Operating system
c) Configuration
d) Security requirements
e) Business application software requirements

B. Provide two (2) high definition 30” monitors

1. Resolution: 1920x1080 with progressive scan
2. Widescreen16:9 aspect ratio

C. Provide UPS for backup power to the Workstation, Monitors, and peripheral equipment

1. Follow provisions of Section 280000 for UPS power requirements
2. Coordinate with Division 26 to provide a dedicated Emergency Power circuit

2.4 PoE NETWORK SWITCH

A. Provide a fully configured rack mounted PoE Managed 10/100/1000Mbps Layer 3 Switch.

1. Coordinate switch make and model with Owner / Owner network representative prior to purchase to ensure compatibility with existing and non-surveillance related network appliances.
2. Coordinate with Owner / Owner network representative on video surveillance subnet assignment.
3. Switch port count shall allow for 10% growth.
4. Provide hot-pluggable optical transceiver modules for optical fiber uplink from Edge to Core network switch. Confirm fiber media type with Owner prior to purchasing transceiver modules.
5. Provide PoE switch with power capacity to accommodate the total connected load.

2.5 MIDSPAN PoE POWER INJECTORS

A. Provide rack mounted power injectors whenever PoE camera power exceeds 15 watts.

B. Provide rack mounted power injectors when PoE camera power exceeds capacity of owner provided Network Switch port power.

2.6 ACCEPTABLE MANUFACTURERS

A. Video Management System (VMS) Platform Software
   1. Genetec Omnicast
   2. Owner Approved Equivalent

B. NVR Server: Compatible with VMS Requirements
   1. NVR specification compliant hardware

C. Workstation Hardware:
   1. Dell
   2. HP
   3. Owner Approved Equivalent

D. Video Monitor:
   1. LG
   2. Optiquest
   3. Samsung
   4. Viewsonic
   5. Owner Approved Equivalent

E. Interior Standard Fixed Camera
   1. American Dynamics
   2. Axis Communications
   3. Bosch
   4. Pelco
   5. Hanwha Techwin (Samsung)
   6. Sony
   7. Vicon
   8. Owner Approved Equivalent

F. Interior Single Sensor Panoramic 180º and 360º Camera
1. American Dynamics  
2. Axis Communications  
3. Bosch  
4. Pelco  
5. Hanwha Techwin (Samsung)  
6. Sony  
7. Vicon  
8. Owner Approved Equivalent  

G. Interior Multi Sensor 180°, 270°, and 360° Camera  
1. American Dynamics  
2. Axis Communications  
3. Bosch  
4. Pelco  
5. Hanwha Techwin (Samsung)  
6. Sony  
7. Vicon  
8. Owner Approved Equivalent  

H. Exterior Standard Fixed Camera  
1. American Dynamics  
2. Axis Communications  
3. Bosch  
4. Pelco  
5. Hanwha Techwin (Samsung)  
6. Sony  
7. Vicon  
8. Owner Approved Equivalent  

I. Exterior Single Sensor Panoramic 180° and 360° Camera  
1. American Dynamics  
2. Axis Communications  
3. Bosch  
4. Pelco  
5. Hanwha Techwin (Samsung)  
6. Sony  
7. Vicon  
8. Owner Approved Equivalent  

J. Exterior Multi Sensor 180°, 270°, and 360° Camera  
1. American Dynamics  
2. Axis Communications  
3. Bosch  
4. Pelco  
5. Hanwha Techwin (Samsung)  
6. Sony  
7. Vicon  
8. Owner Approved Equivalent  

K. Interior / Exterior PTZ Camera
1. American Dynamics
2. Axis Communications
3. Bosch
4. Pelco
5. Hanwha Techwin (Samsung)
6. Sony
7. Vicon
8. Owner Approved Equivalent

L. Wide Angle Megapixel Camera Lens
   1. Computar
   2. Theia
   3. Owner Approved Equivalent

M. Camera Power Supply
   1. Altronix
   2. Alarm-Saf
   3. LifeSafety Power
   4. Owner Approved Equivalent

N. Equipment Racks and Racks Components: (By Division 27)
   1. Chatsworth Products (CPI)
   2. Ortronics
   3. Newton Instruments
   4. Owner Approved Equivalent

O. Lockable Equipment Cabinet and Components:
   1. Chatsworth Products (CPI)
   2. Ortronics
   3. Newton Instruments
   4. Owner Approved Equivalent

P. PoE Network Switch
   1. Brocade
   2. Cisco
   3. Juniper
   4. Arista
   5. Owner Approved Equivalent

Q. Video Wire & Cable
   1. Windy City
   2. General Cable
   3. Belden
   4. CommScope
   5. Owner Approved Equivalent

R. Uninterruptible Power Supply (UPS)
1. Eaton UPS
   a) 5S series for workstations
   b) 9170 for rack mounted equipment

2. APC Smart-UPS Series
   a) SMT series for workstations
   b) Smart-UPS on-Line series for rack mounted equipment

3. MinuteMan
   a) Pro series for workstations
   b) Enterprise Plus series for rack mounted equipment

4. Owner Approved Equivalent

PART 3 - EXECUTION

3.1 CONFIGURATION

A. Video Cameras
   1. Provide day/night cameras in exterior locations
   2. Lenses shall be field tested with Owner present to verify clear, crisp images and desired field of view
      a) Substitute camera lenses as necessary to obtain required field of view at no additional cost
      b) Provide spot filters for exterior lenses as required to reduce picture washout caused by sunlight

B. PoE Cameras
   1. The security integrator shall coordinate network and IP address requirements with Owner to identify the Media Access Control (MAC) address (Layer 2) of each provided camera, the location to be installed, and the port configuration needed for communication.
   2. Make all necessary adjustments to camera lenses to obtain clear, crisp images and desired field of view to the Owners satisfaction.
      a) Substitute camera lenses as necessary to obtain required field of view at no additional cost.
      1) Adjust all cameras to produce high-definition images with no blooming, streaking or noticeable lag.
      2) Provide and install in-line PoE injectors as required when non PoE network switches are used or when manufacturer specified power is not available to the camera.
      3) All camera power shall comply with the specified power requirements.

3.2 POWER REQUIREMENTS
A. Provide uninterruptible power supplies for all active surveillance equipment

1. Rack mounted components, including all active network communication hardware, shall be on an Uninterruptible Power Supply <UPS> system.
2. Refer to Section 280000 for UPS and power requirements
3. Camera power supplies shall be on an Auxiliary Power Supply <APS>, system as required, with a battery backup.
   a) The Auxiliary power supply shall be furnished with a power distribution panel with each camera individually fused or protected with an over-current protector.

B. Power supplies shall provide:

1. 120 VAC input and output voltage as required
2. UL Listed
3. Power fail contacts to monitor the status of the input power
   a) Connect each power supply power fail alarm as a separate alarm input into AC/ID system
4. Key lockable wall mount metal enclosure with tamper switch
5. Independently fused outputs

3.3 INSTALLATION

A. Refer to provisions of Section 280000

B. All surveillance system devices and components shall be compatible.

C. Review landscape drawings, Building Information Model (BIM) files, and field verify landscape and adjacent architectural structures to ensure that video surveillance camera views are on target and unobstructed.

D. Camera Housings and Mounts

1. Cameras shall include housings and mounts as indicated in the Drawings.
   a) Provide the smallest available housing for each camera application.
      1) Integrated miniature dome cameras are preferred
2. Wiring to cameras shall pass from the back-box through the mount and into the housing. Exposed wiring or conduit shall not be acceptable.
3. Provide sun shields for camera housings in outdoor locations exposed directly to sunlight.
4. Provide surge protection for power and copper video cables for exterior cameras at the camera and at the point of termination (security rack).
5. Field verify the exact camera location, position, and mounting prior to installation.
6. Roof mounted cameras shall use roof deck brackets.

E. Video Management Control System

1. System platform software shall be ‘open architecture’ allowing for compatibility and integration with other building automated systems.
2. The system shall allow for secure remote viewing of live and recorded video as required.

F. Provide labeling suitable to Owner for all major equipment components. Coordinate with Owner on numbering scheme to match existing. Major equipment components:

1. Video monitors, IP camera Patch Panels, PoE Switches (or mid-span units), Network Video Recorders (NVR), and fiber mux units (if required).

G. Coordinate with Telecommunication subcontractor for network and patch panel provisions for security connections in the IT room. (If applicable)

H. Coordinate with Owner for all system programming and database requirements.

1. Provide all programming, setup, camera and device titling and data entry
2. Camera and device title and descriptions shall be consistent for all components

I. Install all Point-to-Point wiring with appropriate terminal connections for every wire and component termination so that all connections are mechanically and electrically secure.

J. Install field wiring in continuous lengths, without splices.

K. Verify upon job completion that all wiring and terminations are clearly labeled to identify the wire and terminal.

L. Testing of the surveillance system includes checkout of installed cameras back to the Security head end equipment to confirm proper operation of camera assemblies. Security integrator shall provide all necessary test equipment to fully demonstrate proper performance of field devices. Copies of test results shall be included in the project completion submittals given to the Owner.

END OF SECTION
SECTION 28 2600

EMERGENCY INTERCOMMUNICATIONS AND DURESS

PART 1 - GENERAL

1.1 SUMMARY/OVERVIEW

A. This section provides specifications for the installation of Emergency Intercommunications and Duress (EID) system and related components.

1. Emergency Phones
2. Intercoms
3. Duress Buttons

B. Related Sections

1. Section 087100 Door Hardware
2. Section 260000 Electrical (including related sub-sections)
3. Section 270000 Communications (including related sub-sections)
4. Section 280000 Electronic Security
5. Section 281000 Electronic Access Control and Intrusion Detection
6. Section 282300 Video Surveillance
7. Section 283100 Fire Alarm and Smoke Detection

1.2 REFERENCES

A. See Section 280000 Electronic Security.

1.3 GENERAL SYSTEM DESCRIPTION

A. General Requirements

1. Furnish all labor, materials, tools, equipment, and services for a complete system as indicated and in accordance with provisions of the contract documents.
2. Install per manufacturer’s recommendations.
3. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, and devices incidental to or necessary for a sound, secure and complete installation.
4. Comply with the provisions of Division 1 for General Requirements.
   a) In the event of a conflict between the provisions of this Section and Division 1, the more stringent provisions shall apply.
5. All system devices and components included shall be compatible.

B. The project shall be equipped with a system that is an extension of an existing system maintained by the Owner.
1. All work required within the project for extension of the EID system to the existing system head end shall be furnished and installed by the project security contractor.

C. The EID system will support the needs of the project in accordance with these specifications.
   1. The EID system shall have the capability for future expansion to support the security needs of the completed complex.

D. EID systems utilized for life safety shall comply with all applicable codes.

E. Emergency/UPS power will be utilized to power the EID system’s components at the Security head end equipment location.

1.4 SYSTEM COORDINATION
A. The Security Integrator shall completely coordinate all relevant work of other trades/systems including, but not limited to:

B. Fire Alarm System
   1. Electrical Systems(s)
   2. Telecommunications System(s)

C. Fire Alarm and Life Safety
   1. The security integrator shall coordinate the EID system with the life safety consultant to insure compliance with applicable codes and requirements.

1.5 INTERCOM SYSTEM
A. Master Station
   1. Handset and PTT communication
   2. Door release control
   3. Desk Mount
   4. PoE (802.3af) powered

B. Sub Station
   1. Dry Contact for Door Release
   2. LED illumination for nighttime viewing
   3. IP addressable
   4. PoE (802.3af) powered

1.6 DURESS PANIC BUTTONS
A. The Duress panic button is a switch that allows an individual to covertly send a duress signal, with no visible or audible indication when activated.
   1. Wired Duress Button
a) Switch shall have a shroud over the activating lever that locks in activated position until reset with a key or have two buttons that must be press simultaneously to send alarm

1.7 SUBMITTALS

A. Follow provisions of Section 280000 additional requirements.

1.8 QUALITY ASSURANCE

A. Follow provisions of Section 280000.

B. Spare Parts:

1. Provide the following spare parts:

   a) One (1) emergency phone
   b) One (1) of each type of intercom substation
   c) One (1) emergency duress button
   d) One (1) wireless duress pendant
   e) One (1) area of rescue emergency phone

2. The security integrator will turnover the new and unused components and devices to the owner at project closeout.

1.9 DELIVERY, STORAGE AND HANDLING

A. Follow provisions of Section 280000.

1.10 PROJECT/SITE CONDITIONS

A. Follow provisions of Section 280000.

1.11 WARRANTY

A. Follow provisions of Section 280000.

B. All devices and components shall comply with applicable U.L. standards.

PART 2 - PRODUCTS

2.1 ACCEPTABLE SYSTEM MANUFACTURERS

A. Emergency Duress Buttons

1. United Security
2. Ademco 269
3. Viking PB-1
4. Owner Approved Equivalent

B. Intercom System
1. Aiphone
2. Commend
3. Stentofon
4. Talk-A-Phone
5. Owner Approved Equivalent

C. Wire & Cable
1. Windy City
2. General Cable
3. Belden
4. Owner Approved Equivalent

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS
A. Power Supplies
1. Provide device power supplies for all security system devices requiring power
2. Provide power distribution boards with independently fused outputs.
3. Power supply requirements:
   a) Sealed gel battery backup to provide continuous operation during power failure.
      1) Provide batteries as required to provide specified battery backup time for a
         fully loaded power supply, regardless of the connected load.
   b) A battery charger to maintain the battery.
   c) Low battery and power fail contacts to monitor the status of the input power and the
      battery.
   d) Key lockable wall mount metal enclosure with tamper switch.

B. Video Surveillance System Integration
1. Automatic Video Call-up
   a) Intercom / Phones shall position PTZ cameras and call-up all cameras in the area,
      to the alarm assessment workstation
   b) Record video of alarm calls

C. Tamper Resistant Screws
1. Provide appropriate screw heads for each application (e.g. countersunk heads for recessed
   cover plate screws, flat head screws for standard junction box covers, etc.).
2. The security integrator shall provide Torx® tamper resistant screws for:
3.2 FURTHER REQUIREMENTS

A. Refer to provisions of Section 280000.

B. Furnish and coordinate installation of all special device back boxes and field devices as shown on the security drawings and as specified in this section.

C. The exact installation locations of all equipment shall be coordinated and verified with the Contractor prior to installation.

   1. Subcontractor shall notify the Contractor if any location appears to be unsuitable.

D. Labeling

   1. Provide labeling suitable to Owner for all major equipment components.

      a) Coordinate with Owner on numbering scheme to match existing.

   2. Provide labeling for all security equipment racks and enclosures.

   3. Provide labeling for all security device wiring.

      a) Label all cables and wiring using waterproof, self-adhesive computer printed labels. Label both ends of each cable.

      b) At multi conductor cable terminations label each conductor.

E. Coordinate with the Telecommunications Subcontractor for data network connections and telephone circuits as required.

F. Prepare all systems for user operation.

   1. The security system must be complete and ready to operate prior to Owner final acceptance of the system.

G. Coordinate with the Owner for all system programming requirements.

H. Perform database programming as required to support the security sub-system integration, and control panel configuration as required.

END OF SECTION