

Project Specifications

Volume 2

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BID DOCUMENTS

**JOHNSON COUNTY ADMINISTRATION AND
HEALTH & HUMAN SERVICES BUILDINGS
REMODELING PROJECT
IOWA CITY, IOWA**



ARCHITECTS

INCORPORATED

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**SECTION 21 00 10
FIRE SUPPRESSION GENERAL PROVISIONS**

PART 1 - GENERAL

1.01 GENERAL

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

1.02 DESCRIPTION OF WORK

- A. This section applies to all work under the fire suppression contract. This shall include, but not necessarily be limited to, the following:
 - 1. Water Based Fire Suppression Systems
 - 2. Demolition of Fire Suppression Systems
- B. The work shall include all materials, equipment and labor required for complete and properly functioning fire suppression systems.
- C. Drawings for fire suppression work are in part diagrammatic, intended to convey the scope of work and indicate general arrangement of equipment, piping and approximate sizes and locations of equipment and materials.
- D. Where job conditions require reasonable changes in indicated locations and arrangements, make such changes without additional cost to Owner.
- E. Because of the scale of the drawings, certain piping or items such as unions or fittings may not be shown, but where such items are required by other sections of the specifications, or where they are required by the nature of the work, they shall be furnished and installed.
- F. All elements of the construction shall be performed by workmen skilled in the particular craft involved, and regularly employed in that particular craft.
- G. All work shall be performed in a neat, workmanlike manner in keeping with the highest standards of the craft.

1.03 CODES AND STANDARDS

- A. All work shall be done in accordance with the applicable portion of the following codes and standards:
 - 1. International Fire Suppression Code
 - 2. Uniform Plumbing Code
 - 3. International Building Code
 - 4. National Electric Code (NEC)
 - 5. National Fire Protection Association Standards (NFPA)
 - 6. Local Utility Company Requirements
 - 7. Local Codes, all trades
 - 8. Standards of ASME, ASHRAE, NEMA, IEEE, AGA, SMACNA
 - 9. Occupational Safety and Health Administration (OSHA)
 - 10. Underwriters Laboratories, Inc. (U.L.)
 - 11. Iowa Administrative Codes
 - 12. Americans With Disabilities Act (ADA)
- B. Contractors shall familiarize themselves with all codes and standards applicable to their work and shall notify Design Professional of any discrepancies between the design and applicable code requirements so that any conflicts can be resolved. Where two or more codes or standards are in conflict, that requiring the highest order of workmanship shall take precedence, but such questions shall be referred to Design Professional for final decision.
- C. Where drawings or specifications call for workmanship or materials in excess of code requirements, a lower grade of construction will not be permitted.

1.04 REQUIREMENTS & FEES OF REGULATORY AGENCIES

- A. Contractor shall comply with the rules and regulations of the authorities having jurisdiction and local utility companies. Contractor shall check with each utility company providing service to this project and determine or verify their requirements regarding incoming services.
- B. Secure all required permits and pay for all inspections, licenses and fees required in connection with the fire suppression work. Contractor shall post all bonds and obtain all licenses required by the State, City, County and Utility.

1.05 FIRE SUPPRESSION DRAWINGS

- A. The fire suppression drawings indicate in general the building arrangement only, Contractor shall examine all construction drawings to familiarize himself with the specific type of building construction, i.e. type of structural system, floors, walls, ceilings, room finishes and elevations.
- B. Drawings for piping are intended to convey the scope of the work and to indicate the general arrangement and locations of piping and equipment.
- C. Contractor shall layout his own work and shall be responsible for determining the exact locations for equipment and rough-ins and the exact routing of piping so as to best fit the layout of the work.
- D. Contractor shall take his own field measurements for verifying locations and dimensions: scaling of the drawings will not be sufficient for laying out the work.
- E. Because of the scale of the drawings, certain basic items such as pipe fittings and valves may not be shown, but where such items are required by code or by other sections of the specifications, such items shall be furnished and installed.

1.06 ACTIVE SERVICES

- A. Contractor shall be responsible for verifying exact location of all existing services prior to beginning work in that area.
- B. Existing active services, i.e., water, gas, sewer, electric, when encountered, shall be protected against damage. Do not prevent or disturb operation of active services which are to remain.
- C. When active services are encountered which require relocation, Contractor shall make request to authorities with jurisdiction for determination of procedures.
- D. Where existing services are to be abandoned, they shall be terminated in conformance with requirements of the authorities having jurisdiction.

1.07 SITE INSPECTION

- A. Contractor shall inspect the site prior to submitting bid for work to familiarize himself with the conditions of the site which will affect his work and shall verify points of connection with utilities, routing of outside piping to include required clearances from any existing structures, trees or other obstacles.
- B. Extra payment will not be allowed for changes in the work required because of the contractor's failure to make this inspection.

1.08 COORDINATION AND COOPERATION

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

- C. Drawings and specifications are intended to be complimentary. Any work shown in either of them, whether in the other or not, shall be executed according to the true intent and meaning thereof, the same as if set forth in all. Conflicts between the drawings and the specifications, or between the requirements set forth for the various contractors, shall be called to the attention of the Design Professional. If clarification is not asked for prior to the taking of bids, it will be assumed that none is required and that Contractor is in agreement with the drawings and specifications as issued. If clarification is required after the contract is awarded, such clarification will be made by the Design Professional and his decision will be final.
- D. Special care shall be taken for protection for all equipment. All equipment and material shall be completely protected from weather elements, painting and plaster until the project is substantially completed. Damage from rust, paint and scratches shall be repaired as required to restore equipment to original condition.
- E. Protection of all equipment during the painting of the building shall be the responsibility of the painting contractor, but this shall not relieve Contractor of the responsibility for checking to assure that adequate protection is being provided.
- F. Where the final installation or connection of equipment in the building requires Contractor to work in finished areas of the building, Contractor shall be responsible that such areas are protected and are not marred, soiled or otherwise damaged during the course of such work. Contractor shall arrange with General Contractor for patching and refinishing of such areas which may be damaged in this respect.

1.09 OPENINGS, CUTTING AND PATCHING

- A. Piping and sleeves passing through all fire or smoke rated floors, roofs, walls, and partitions shall be provided with firestopping. Space between wall/floor and pipe or sleeve shall be sealed with UL listed intumescent fire barrier/ Firestopping material equivalent to rating of wall/floor. Where piping and sleeves pass through floors, roofs, walls and partitions that are not fire or smoke rated, penetrations shall be sealed with grout or caulk. Refer to Section 07 8400 – Firestopping and Section 07 92 00 – Joint Sealants for additional information.
- B. New structure:
 - 1. Contractor will coordinate the placing of openings and lintels in the new structure as required for the installation of the fire suppression work with the General Contractor.
 - 2. Contractor shall furnish to General Contractor the accurate locations and sizes for required openings, but this shall not relieve Contractor of the responsibility of checking to assure that proper size openings are provided. When additional cutting and patching is required due to Contractor's failure to coordinate this work, Contractor shall make arrangements for the cutting, patching, and painting required.
- C. Existing Structure:
 - 1. Contractor shall provide cutting, lintels and patching, and patch painting in the existing structure, as required for the installation of his work, and shall furnish lintels and supports as required for openings.
 - 2. Cutting of structural support members will not be permitted without prior approval of the Design Professional. Extent of cutting shall be minimized; use core drills, power saws or other machines which will provide neat, minimum openings.
 - 3. Patching shall match adjacent materials and surfaces and shall be performed by craftsmen skilled in the respective craft required.

1.10 MATERIALS AND EQUIPMENT

- A. All materials and equipment shall be the standard product of a reputable U.S.A. manufacturer regularly engaged in the manufacture of the specified item. Where two or more units are required of the same item, they shall be furnished by the same manufacturer except where specified otherwise.
- B. All material and equipment shall be installed in strict accordance with the manufacturer's recommendations.

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

1.11 SUBMITTALS

- A. Contractor shall furnish to Design Professional, complete sets of shop drawings and other submittal data. Contractor shall review and sign shop drawings before submittal. Refer to Division 01 specifications for additional requirements. Refer to Section 01 30 00 - Administrative Requirements for additional requirements.
- B. Shop drawings shall be bound into sets and cover related items for a complete system as much as practical and shall be identified with symbols or "plan marks" used on drawings. Incomplete, piecemeal or unbound submittals will be rejected.
- C. Submittals required by the various sections of the Project Manual include, but are not necessarily limited to those identified in the submittal schedule below.
- D. After award of contract, Contractor shall provide a completed submittal schedule including dates that the submittals will be to Design Professional for review.
- E. Submit required information on the following items:

SPEC SECTION	EQUIPMENT	DETAIL DWGS	PROD DATA	SAMPLES	INSTALL METHODS	O & M MANUAL	CERTIFICATE OF DEMONSTRATION	OTHER (SEE NOTES)
21 10 00	Water Based Fire Suppression System	X	X			X	X	1, 2

Notes:

- 1. Hydraulic calculations.
- 2. All certifications and test results required by NFPA.

- F. Design Professional will review shop drawings solely to assist contractors in correctly interpreting the plans and specifications.
- G. Contract requirements cannot be changed by shop drawings which differ from contract drawings and specifications.

1.12 OPERATION AND MAINTENANCE MANUALS

- A. Operation and maintenance manuals shall be submitted to Design Professional in duplicate upon completion of the job. Refer to Division 01 specifications for additional information.
- B. Submit manuals in duplicate upon completion of the job. Manuals shall be bound in a three-ring hard-backed binder. Front cover and spine of each binder shall have the following lettering done:

OPERATION
AND
MAINTENANCE
MANUAL
FOR
FIRE SUPPRESSION SYSTEMS

(PROJECT NAME)
(LOCATION)
(DATE)

SUBMITTED BY
(NAME AND ADDRESS OF CONTRACTOR)

- C. Provide a master index at the beginning of manual showing items included. Use plastic tab indexes for sections of manual. Each section shall contain the following information for equipment furnished under this contract:
1. Equipment and system warranties and guarantees.
 2. Installation instructions.
 3. Operating instructions.
 4. Maintenance instructions.
 5. Spare parts identification and ordering list.
 6. Local service organization, address, contract and phone number.
 7. Shop drawings with reviewed stamp of Design Professional and Contractor shall be included, if applicable, along with the items listed above.
 8. Reports of all tests and demonstrations including certificate of owner instruction, testing and balancing report, etc.

1.13 TRAINING AND DEMONSTRATIONS

- A. Prior to acceptance of the fire suppression installation, Contractor shall provide to Owner, or his designated representatives, all comprehensive training on essential features and functions of all systems installed, and shall instruct Owner in the proper operation and maintenance of such systems.
1. Provide adequate notice to Owner as to when instruction will be conducted so appropriate personnel can be present.
 2. Prepare the instruction format for a minimum of four Owner Representatives.
- B. Equipment training:
1. Manufacturer's representatives shall provide instruction on each major piece of equipment. Contractor shall provide instruction on all other equipment.
 2. Training sessions shall use the printed installation, operation and maintenance instruction materials included in the O&M manuals and emphasize preventative maintenance and safe operating procedures.
 3. Training shall be performed by qualified factory trained technicians.
 4. Contractor shall attend all sessions performed by the manufacturer's representative and shall add to each session any special information relating to the details of installation of the equipment as it might impact the operation and maintenance.
 5. Equipment training shall occur as soon as possible after start up of the equipment and shall include hands-on operation. Training shall be provided for equipment listed in the table below.
- C. The following are minimum requirements for Owner instruction:

Section	Description	Hours (Note 1)	Presented By	Others Present	Remarks
21 10 00	Water Based Fire Suppression System	4	Contractor		
1. Any unused hours shall be used at Owner's discretion during the first year of occupancy.					

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

CERTIFICATE OF SYSTEM DEMONSTRATION

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

- A. Project:
- B. System(s):
- C. Contractor's representatives giving instruction and demonstration:

Contractor: _____

NAMES	DATE	HOURS

- D. Owner's representatives receiving instruction:

Owner: _____

NAMES	DATE	HOURS

- E. Acknowledgement of demonstration:

Contractor's Representative:

_____ signature

_____ date

Owner's Representative:

_____ signature

_____ date

1.14 SUBSTITUTIONS

- A. Refer to Divisions 00 and 01.
- B. Where substitutions are approved, Contractor assumes all responsibility for physical dimensions and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of the substitution.

1.15 ACCEPTABLE MANUFACTURERS

- A. In most cases, equipment specifications are based on a specific manufacturer's type, style, dimensional data, catalog number, etc. Listed with the base specification, either in the manual or on the plan schedules are acceptable manufacturers approved to bid products of equal quality. These manufacturers are encouraged to submit to Design Professional at least 8 days prior to the bid due date drawings and catalog numbers of products to be bid as equals.
- B. Manufacturers who do not submit prior to bidding, run the risk of having the product rejected at time of shop drawing submittal. Extra costs associated with replacing the rejected product shall be the responsibility of the contractor and/or the manufacturer.
- C. If Contractor chooses to use a manufacturer listed as an equal, it shall be his responsibility to assure that the manufacturer has complied with the requirements in 'A' above. Contractor shall assume all responsibility for physical dimensions (including accessibility for maintenance), operating characteristics, and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of using the alternate manufacturer.
- D. Where a model or catalog number is provided, it may not be inclusive of all product requirements. Refer to additional requirements provided on the plans or in the specifications as required. Similarly, there may be additional requirements included in the model or catalog number that are not specifically stated. These requirements shall also be met.

1.16 WARRANTY

- A. Refer to Divisions 00 and 01 for information on warranties and correction of work within the warranty period.
 - 1. If a warranty or warranty period are not defined in Division 00 or 01, then the start of all warranty periods shall be the date of Substantial Completion and the length of the warranty shall be for one year.
 - a. If construction is phased with distinct and separate Substantial Completion dates for portions of the building and/or systems, separate warranties shall be provided for each of these phased areas and/or systems.
 - b. The entire Fire Suppression system, including all sub-systems, shall be guaranteed against defect in materials and installation for the duration of the warranty period. Any malfunctions or defects which occur within the warranty period shall be promptly corrected without cost to the Owner. This guarantee shall not limit or void any manufacturer's express or implied warranty.
- B. Refer to other Division 21 sections for systems, equipment, or material requiring extended warranties.
- C. The date of systems/equipment startup or equipment/material shipment to the site shall not be considered the notable date with relation to the warranty of that item. All systems, equipment, material, etc., shall have the same start date with respect to the warranty period.
- D. Systems, equipment or material put into use to facilitate construction activities (e.g. testing and balancing, commissioning, temporary conditioning, etc.) prior to the start of the warranty period shall not impact the length of the warranty in any way.

1.17 COMPLETION

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

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

1.18 CLEANING

- A. At the conclusion of the construction, the entire system of piping and equipment shall be cleaned internally.
- B. All temporary labels, stickers, etc., shall be removed from all fixtures and equipment. Name plates, ratings, instruction plates, etc., shall not be obscured by paint, insulation, or placement of units.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 21 00 10

**SECTION 21 05 00
COMMON WORK RESULTS FOR FIRE SUPPRESSION**

PART 1 - GENERAL

1.01 GENERAL

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

1.02 DESCRIPTION OF WORK

- A. This section includes the following:
 - 1. Sleeves
 - 2. Escutcheons
 - 3. Fire Stopping
 - 4. Guards
 - 5. Demolition

PART 2 - PRODUCTS

2.01 DEMOLITION MATERIALS

- A. All materials removed shall be the property of the removing contractor and shall be removed from the site by him, unless otherwise specified.

2.02 SLEEVES

- A. Sleeves passing through non load bearing walls and partitions shall be galvanized sheet steel with lock seam joints of minimum gauges as follows:
 - 1. For pipes 2 1/2" and smaller 24 gauge
 - 2. For pipes 3" to 6" 22 gauge
 - 3. For pipes over 6" 20 gauge
- B. Sleeves passing through load bearing walls, concrete beams, fireproof walls, foundations, footings and waterproof floors shall be Schedule 40 steel pipe or cast iron pipe.
- C. Sleeves are not required in masonry walls which are core drilled or walls of drywall construction, except where partition is a firestop, smokestop, or side of air plenum.
- D. Sleeves for insulated piping shall be of sufficient internal diameter to take pipe and insulation and to allow for free movement of pipe. Waterproof sleeves shall be of sufficient internal diameter to take pipe and waterproofing material.
- E. In finished areas where pipes are exposed, sleeves shall be terminated flush with wall, partitions and ceilings, and shall extend 1/2" above finished floors. Extend sleeves 1" above finished floors in areas likely to entrap water and fill space between sleeves and pipe with graphite packing and caulking compound.
- F. Sleeves passing through membrane waterproofing or lead safe shall be provided with flashing, furnished and installed by General Contractor, extending 12" beyond sleeve in all directions; flashing shall be secured and sealed to membrane or lead safe and shall be sealed to sleeve and caulked watertight. Sleeves passing through roof shall be installed in same manner except sleeves shall extend to 6" above roof.
- G. For exterior walls below grade, sleeves shall be cast iron. Space between sleeve and pipe shall be sealed with modular rubber links tightened with bolts (Link-Seal or equal).

2.03 ESCUTCHEONS

- A. Provide chrome plated escutcheons at each sleeved opening into finished spaces. Escutcheons shall fit around pipe; outside diameter shall cover sleeve. Where sleeve extends above finished floor, escutcheon shall be high cap type and shall clear sleeve extension. Secure escutcheons or plates to sleeve with set screws or other approved devices.

2.04 FIRESTOPPING

- A. Piping and sleeves passing through all fire or smoke rated floors, roofs, walls, and partitions shall be provided with firestopping. Space between wall/floor, pipe, and sleeve, shall be sealed with UL Listed intumescent fire barrier material equivalent to rating of wall/floor. Refer to Section 07 84 00 – Firestopping for additional information.

PART 3 - EXECUTION

3.01 DEMOLITION

- A. General
 - 1. Demolition shall be accomplished by the proper tools and equipment for the work to be removed. Personnel shall be experienced and qualified in the type of work to be performed.
 - 2. Contractor shall remove existing equipment and piping not necessary for additions or existing portions of building as indicated on drawings and/or specified herein. To include all abandoned equipment and piping back to point of origin. Demolition of equipment shall include removal of associated concrete equipment pad and/or support steel.
 - 3. Contractor shall be responsible for the cutting and capping of all existing services before any work is commenced by the General Contractor.
- B. Work by Others: Unless specifically noted under other contracts, Contractor shall assume all required work shall be performed by him. In general, the following will be performed by others:
 - 1. General Contractor will remove any floors, walls and ceilings, neatly patch, match, complete and finish all affected surfaces.
 - 2. Electrical Contractor will disconnect all electrical services and remove abandoned conduit back to point of origin.
- C. Existing Conditions:
 - 1. If any piping serving existing fixtures or equipment which are to remain are disturbed by operations under this Contract, Contractor shall provide pipe and insulation required to reestablish continuity of such piping systems.
 - 2. Contractor shall arrange for General Contractor to repair, patch and paint all construction, with material necessary to match surrounding material, which is necessary due to removal of equipment and piping.
 - 3. Contractor shall furnish all required labor and material where required to extend new work to connect to similar work where new addition adjoins existing building and for extension of existing system. Connection shall be made in a suitable manner.
- D. Owner's Right of Salvage: The Owner may designate and have salvage rights to any material herein demolished by the Contractor.

3.02 SLEEVES

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

3.03 ESCUTCHEONS

- A. Install escutcheons for all pipes entering finished spaces.

END OF SECTION 21 05 00

**SECTION 21 05 53
IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT**

PART 1 - GENERAL

1.01 RELATED WORK

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

1.02 DESCRIPTION OF WORK

- A. Extent of fire suppression identification work required by this section is indicated on drawings and/or specified in other Division 21 sections.
- B. Type of identification devices specified in this section include the following:
 - 1. Painted identification materials
 - 2. Plastic pipe markers
 - 3. Plastic tape
 - 4. Valve tags
- C. Identification furnished as part of factory fabricated equipment, is specified as part of the equipment assembly in other Division 21 sections.

1.03 QUALITY ASSURANCE

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

1.04 SUBMITTALS

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

PART 2 - PRODUCTS

2.01 IDENTIFICATION MATERIALS

- A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 21 sections. Where more than one single type is specified for an application, selection is Installer's option, but provide single selection for each product category.
- B. Painted Identification Materials:
 - 1. Stencils: Standard fiberboard stencils, prepared for required applications with letter sizes generally complying with recommendations of ANSI A13.1 for piping and similar applications, but not less than 3/4" high letters for access door signs and similar operational instructions.
 - 2. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray can form and grade.
 - 3. Identification Paint: Standard identification enamel of colors indicated, or, if not otherwise indicated for piping systems, comply with ANSI A13.1 for colors.
- C. Plastic Pipe Markers:
 - 1. General: Provide manufacturer's standard preprinted flexible or semi rigid, permanent, color coded, plastic sheet pipe markers, complying with ANSI A13.1.
 - 2. Small Pipes: For external diameters not greater than 6" (including insulation if any), provide full band pipe markers extending 360 degrees around pipe at each location, fastened by one of the following methods:
 - a. Snap on application of pre tensioned semi rigid plastic pipe marker.

- b. Adhesive lap joint in pipe marker overlap.
 - c. Laminated or bonded application of pipe marker to pipe (or insulation).
 - d. Taped to pipe (or insulation) with color coded plastic adhesive tape, not less than 3/4" wide full circle at both ends of pipe marker, tape lapped 1 1/2".
3. Large Pipes: For external diameters of 6" and larger (including insulation if any), provide either full band or narrow strip type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:
 - a. Laminated or bonded application of pipe marker to pipe (or insulation).
 - b. Taped to pipe (or insulation) with color coded plastic adhesive tape, not less than 1 1/2" wide; full circle at both ends of pipe marker, tape lapped 3".
 - c. Strapped to pipe (or insulation) application of semi rigid type, with manufacturer's standard stainless-steel bands.
 4. Lettering: Manufacturer's standard preprinted nomenclature which best describes piping system in each instance, as selected by Design Professional in cases of variance with names as shown or specified.
 5. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as a separate unit of plastic.
- D. Plastic Tape:
1. General: Manufacturer's standard color-coded pressure sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.
 - a. Width: Provide 1 1/2" wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6", 2 1/2" wide tape for larger pipes.
 - b. Color: Comply with ANSI A13.1, except where another color selection is indicated.
- E. Valve Tags:
1. Brass Valve Tags: Provide polished brass valve tags with stamp engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 7/16" high, and with 3/16" hole for fastener. Tag thickness 0.040 inches.
 - a. Provide 2" diameter tags, except as otherwise indicated.
 - b. Fill tag engraving with black enamel.
 2. Plastic Valve Tags: Provide red heavy plastic tag with 7/16" white embossed sequenced numbers.
 3. Valve Tag Fasteners: Manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S hooks or heat-sealed braided copper wire of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
- F. Name Plates:
1. General: Provide manufacturer's standard preprinted plastic, brass, or aluminum with stamped, engraved or embossed letters.
 2. Lettering:
 - a. Large Equipment: 1 1/2" lettering as appropriate.
 - b. Small Equipment: 3/4" lettering as appropriate.
 3. Attachments: Mounting holes and screws, pressure sensitive adhesive backing, or solid brass chain.

2.02 LETTERING AND GRAPHICS

- A. General: Coordinate names, abbreviations and other designations used in fire suppression identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of fire suppression systems and equipment.
1. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Fire Pump, Standpipe F12).

PART 3 - EXECUTION

3.01 APPLICATION AND INSTALLATION

- A. General Installation Requirements:
 - 1. Coordination: Where identification is to be applied to surfaces which require painting or other covering or finish including valve tags, install identification after completion of covering and painting if any. Install identification prior to installation of acoustical ceilings and similar concealment.
- B. Piping System Identification:
 - 1. General: Install pipe markers of one of the following types on all fire suppression piping, and include arrows to show normal direction of flow:
 - a. Stenciled markers, including color coded background band or rectangle, and contrasting lettering of black or white. Extend color band or rectangle 2" beyond ends of lettering.
 - b. Plastic pipe markers, with application system as indicated under "Materials" in this section.
 - c. Stenciled markers, black or white for best contrast, wherever continuous color coded painting of piping is provided.
 - 2. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non concealed locations.
 - a. Near each valve and control device.
 - b. Near locations where pipes pass through walls or floors/ceilings, or enter non accessible enclosures.
 - c. At access doors, manholes and similar access points which permit view of concealed piping.
 - d. Near major equipment items and other points of origination and termination.
 - e. Spaced intermediately at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment.
 - f. On piping above removable acoustical ceilings.
- C. Valve Identification:
 - 1. General: Provide valve tag on every valve, cock and control device in fire suppression piping system; exclude check valves. List each tagged valve in valve schedule for each piping system.
- D. Equipment Identification:
 - 1. General: Provide equipment identification for all equipment including fire pumps, fire pump controllers, zone control valves, and specialty system valves where applicable (i.e. dry valve or preaction system).
 - 2. Labeling: All equipment shall be labeled as per construction document plan marks or as designated by Owner.
 - 3. Provide identification by means of nameplates or stenciled painting as appropriate.
 - a. For equipment with factory furnished casing, identification shall be by adhesive fixed name plates.

END OF SECTION 21 05 53

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**SECTION 21 10 00
WATER-BASED FIRE SUPPRESSION SYSTEMS**

PART 1 - GENERAL

1.01 RELATED WORK

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

1.02 DESCRIPTION OF WORK

- A. Extent of fire suppression work is indicated on drawings and schedules, and by requirements of this section.
- B. Applications of fire suppression systems include the following:
 - 1. Sprinkler systems.
 - 2. Standpipe systems.

1.03 QUALITY ASSURANCE

- A. NFPA Code: Comply with ANSI/NFPA 13, "Installation of Sprinkler Systems", and ANSI/NFPA 24, "Private Fire Service Mains and Their Appurtenances", where applicable.
- B. UL Labeling: Provide fire sprinkler piping products which have been approved and labeled by Underwriters Laboratories.
- C. Local Fire Marshal Regulations: Comply with governing regulations pertaining to fire sprinkler piping.
- D. All fire suppression work shall be performed by a qualified sprinkler contractor with at least three years' experience that has obtained current certification in the State of Iowa under the Fire Extinguishing System Contractor Certification program. During the installation, a minimum of one person with at least three years sprinkler experience shall be present.
- E. All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
- F. All castings used for couplings housings, fittings, or valve and specialty bodies shall be date stamped for quality assurance and traceability.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's data for fire suppression systems, materials and products.
- B. Piping Shop Drawing and Hydraulic Calculations: The Contractor shall prepare a complete set of detailed working drawings and hydraulic calculations showing all equipment, fire service lines, risers, piping and heads. These drawings and calculations shall be approved in writing or stamped approved by the authorities having jurisdiction. Contractor is responsible for any fees associated with the review and approval of the fire suppression layout drawings, product data and hydraulic calculations by the Fire Marshal's office.
- C. Sprinklers shall be referred to on drawings, submittals and other documentation, by the sprinkler identification or Model number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed
- D. Grooved joint couplings and fittings shall be referred to on drawings and product submittals, and be identified by the manufacturer's listed model or series designation.
- E. Certificate of Installation: Submit certification upon completion of fire suppression piping work which indicates that work has been tested in accordance with ANSI/NFPA 13 and also that system is operational, complete and has no defects.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Fire Suppression Specialties
 - 1. Reliable Sprinkler Corporation.
 - 2. Tyco.
 - 3. Viking Corp.
 - 4. Globe Fire Sprinkler Corporation
 - 5. Victaulic
 - 6. Potter
 - 7. System Sensor
- B. Backflow Preventers
 - 1. Watts
 - 2. Apollo Valves
 - 3. Febco
 - 4. Zurn Wilkins
- C. Gate Valves
 - 1. NIBCO
 - 2. Powell
 - 3. Milwaukee
 - 4. Watts
 - 5. Victaulic
- D. Bronze Body Butterfly Valves
 - 1. NIBCO
 - 2. Milwaukee
- E. Butterfly and Swing Check Valves
 - 1. Victaulic
 - 2. Gruvlok by Anvil International
 - 3. Kennedy
 - 4. Milwaukee
 - 5. NIBCO
- F. Ball Valves
 - 1. Watts B-6000 Series
 - 2. Milwaukee BA-100/BA-150
 - 3. NIBCO T-580 Series
 - 4. Apollo 77C Series
 - 5. Victaulic
- G. Grooved Piping Systems
 - 1. Gruvlok by Anvil International
 - 2. Victaulic
- H. Fire Department Connections
 - 1. Larsen's Manufacturing Company
 - 2. Guardian Fire Protection Equipment
 - 3. Potter-Roemer
 - 4. Croker

2.02 FIRE SUPPRESSION SPECIALTIES

- A. General: Provide fire suppression specialties, UL listed, in accordance with the following listing. Provide sizes and types which mate and match piping and equipment connections.
 - 1. Water Flow Indicators: Provide vane type water flow detectors.
 - 2. Outdoor Alarm Bell: Provide electric alarm bell in accordance with NFPA 13. Coordinate installation with Electrical Contractor.

3. Supervisory Switches: Provide products recommended by manufacturer for use in service indicated.
4. Automatic Sprinklers:
 - a. Provide automatic sprinklers of type indicated on drawings, and in accordance with the following listing. Provide liquid bulb, ordinary temperature, except where intermediate or high temperature rated sprinklers are required per NFPA 13 or as indicated on the plans.
 - 1) Upright
 - 2) Concealed Pendent with Flat Cover Plate
 - 3) Pendant
 - 4) Standard Dry-Type Pendent
 - 5) Standard Dry-Type Upright
 - 6) Dry-Type Concealed Pendent with Flat Cover Plate
 - b. Finish: Painted white for concealed pendent, cast brass for upright pendent, chrome for recessed pendent or provide finish as indicated on the plans. Where existing sprinkler systems are being modified or expanded, match existing head type.
5. Sprinkler Cabinet and Wrench: Furnish steel, baked red enameled, sprinkler box with capacity to store 10 sprinklers and wrench sized to sprinklers.
6. Escutcheons and guards shall be listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer.
7. Wrenches shall be provided by the sprinkler manufacturer that directly engage the wrench boss cast in the sprinkler body.

2.03 CONNECTIONS AND TEST HEADERS

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

2.04 BACKFLOW PREVENTERS

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

2.05 VALVES

- A. Butterfly - 1/4" to 2" Milwaukee Butterball BB2 Series
- B. Ball - 2" to 3" Victaulic Series 727
- C. Butterfly - 4" to 8" Victaulic Series 705 (Normally Open Valves) or Series 707C (Normally Closed Valves)
- D. Gate - 2-1/2" and larger, iron body O.S.&Y., Powell Fig. 1797
- E. Check - 2-1/2" to 3", Central Model 90, 4" to 8" Victaulic Series 717
- F. Zone Control valve with Check Assembly – 1 1/4" – 8" Victaulic Model Globe UMC

2.06 PIPE MATERIALS

	<u>Material</u>	<u>Service</u>
A.	Ductile iron pipe ANSI A21.5 ANSI/AWWA C151.	Underground water service main, 4" dia. and larger, above ground water service main up to inlet of fire pump or backflow preventer
B.	Polyvinyl Chloride Pipe (PVC) DR18 ANSI/AWWA C900 or C905 With tracer wire	Underground water service main.
C.	Black steel pipe, Schedule 40, ASTM A795	Wet systems.
D.	Black steel pipe, Schedule 10, ASTM A795	Wet systems.

2.07 PIPE FITTINGS

A. Steel Pipe:

1. Threaded pipe (2" dia and smaller): Malleable or Ductile iron fittings, 150 pound standard flat band water pattern.
2. Welded pipe (2 1/2" dia and larger): Standard radius weld fittings and weld neck or slip-on flanges, same material and strength as pipe.
3. Mechanical grooved and roll-groove steel piping system and fittings: may be used as approved by code for black steel, stainless steel and galvanized steel. All components shall be by one manufacturer. System installation shall be in accordance with the manufacturer's recommendations.
 - a. In lieu of groove type couplings and fittings, Victaulic Installation-Ready™ fittings for Schedule [40] [10] grooved end steel piping in fire protection applications sizes NPS 1-1/4" thru 2 1/2", consisting of a ductile iron housing conforming to ASTM A-536, Grade 65-45-12, with Installation-Ready™ ends, prelubricated Grade "E" EPDM Type 'A' gasket, and ASTM A449 electroplated steel bolts and nuts. UL listed for a working pressure of 300 psi (2065 kPa) and FM approved for working pressure 365 psi (2517kPa).
 - b. Grooved joint fittings shall be ductile iron conforming to ASTM A-536 Grade 65-45-12, short-pattern with flow equal to standard pattern fittings. Basis of Design: Victaulic FireLock.

B. Flexible, Sprinkler Hose Fittings:

1. In lieu of rigid pipe offsets or return bends for sprinkler drops, the Victaulic VicFlex™ Multiple-Use Flexible Stainless Steel Sprinkler Drop System [with captured coupling Style 108] may be used to locate sprinklers as required by final finished ceiling tiles and walls. The drop system shall consist of a braided type 304 stainless steel flexible tube, zinc plated steel Male threaded nipple or Victaulic FireLock IGS Groove Style 108 coupling for connection to branch-line piping, and a zinc plated steel reducer with a female thread for connection to the sprinkler head.
2. The drop shall include a UL approved Series AH1 with 3" bend radius; AH2 or AH2-CC braided hose with a bend radius to 2" to allow for proper installation in confined spaces.
3. Union joints shall be provided for ease of installation.
4. The flexible drop shall attach to the ceiling grid using a one-piece open gate Series AB1 or AB2 bracket. The bracket shall allow installation before the ceiling tile is in place.
5. The braided drop system is UL listed for sprinkler services to 175 psi (1206 kPa) and FM Approved to 200 psi (1380 kPa).
6. Flexible Sprinkler drop shall be Victaulic VicFlex™ Multiple-Use Flexible Stainless Steel Sprinkler Drop System or approved equal.
 - a. In lieu of rigid connections to dry sprinkler heads, a Victaulic VicFlex™ dry sprinkler, Model VS1, may be used. The sprinkler shall provide a vertical or horizontal flexible connection with a bend radius to 2", and allow for up to 4 bends.

- b. In lieu of rigid pipe offsets or return bends for sprinkler drops in wet systems in cold storage applications, the Victaulic VicFlex™ V33, V36, or V40 Dry Sprinkler with Integral AB6 Assembly may be used.

2.08 JOINTS

A. Steel Pipe:

1. Threaded pipe (2" dia and smaller): Make joints using Teflon tape applied to male threads only. Cut pipe square, cut threads clean, remove burrs and ream ends to full size of bore.
2. Welded pipe (2 1/2" dia and larger): Welding shall conform to welding section of ANSI-B31.3 "Code for Power Piping."
3. Mechanical grooved and roll-groove pipe couplings: Grooved couplings may be used as approved by code for black steel and galvanized steel piping. Gasket type to be used shall be appropriate for intended service. All components shall be by one manufacturer. System installation shall be in accordance with the manufacturer's recommendations.
 - a. In lieu of groove type couplings and fittings, Victaulic Installation-Ready™ fittings for Schedule [40] [10] grooved end steel piping in fire protection applications sizes NPS 1-1/4" thru 2 1/2", consisting of a ductile iron housing conforming to ASTM A-536, Grade 65-45-12, with Installation-Ready™ ends, prelubricated Grade "E" EPDM Type 'A' gasket, and ASTM A449 electroplated steel bolts and nuts. UL listed for a working pressure of 300 psi (2065 kPa) and FM approved for working pressure 365 psi (2517kPa).
 - b. Grooved joint fittings shall be ductile iron conforming to ASTM A-536 Grade 65-45-12, short-pattern with flow equal to standard pattern fittings. Basis of Design: Victaulic FireLock.

2.09 NIPPLES AND UNIONS

- A. All nipples shall conform to size, weight and strength of adjoining pipe. When length of unthreaded portion of nipple is less than 1-1/2", use extra strong nipple; do not use close nipples.
- B. For pipe 2" and smaller, use screwed unions, for pipe 2-1/2" and over use flanged unions. For steel pipe use black or galvanized malleable iron unions, to conform to pipe with ground joint. Cast iron flanged unions gasket type. For threaded brass pipe, use bronze ground joint unions with octagon ends.
- C. Install unions in the following locations so that a minimum amount of pipe need be disassembled:
 1. Long runs, at intervals of 80 feet.
 2. In by-pass around equipment, valves, and controls.
 3. In connections to equipment.
 4. Where indicated on drawings.

PART 3 - EXECUTION

3.01 GENERAL

- A. Contractor shall familiarize himself with the general construction, plumbing, heating, ventilating, and electrical work and to use the information to avoid conflicts in space allocation with the other trades. Do not place pipes over electrical equipment.
- B. In the case of an interference occurring during construction, Contractor shall rework and reinstall piping and equipment in order to make space available for another contractor's equipment without additional cost to the Owner.
- C. Contractor shall work closely with the ceiling system installers and install sprinkler head drops before ceiling tiles are installed, and return to job after or during ceiling tile installation for installation of sprinkler heads.
- D. Heads shall be located in center of ceiling tiles or as directed by Design Professional.

3.02 FIRE SUPPRESSION SPECIALTIES

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

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

3.03 BACKFLOW PREVENTERS

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

3.04 VALVES

- A. Install valves as indicated on the drawings and as specified herein. Install sectional valves in inlet piping at bottom of each riser and in loops as indicated. Locate valves for easy access and operation. Do not locate valves with stems below horizontal. Mount supervisory switches on each sectional valve.
- B. Install valves in equipment rooms to provide easy access to valve. Each valve installed 8'-0" above the floor shall be provided with chain operator. Bottom of chain operator shall be 7'-0" above floor.
- C. Check valves shall not be installed in vertical runs of piping unless they are specifically designed for vertical operation.
- D. Normally Open (N.O.) or Normally Closed (N.C.) valves shall be provided as required for intended system operation. For all supervised valves, the off-normal signal shall be initiated during the first two revolutions of the hand wheel or during one-fifth of the travel distance of the valve control apparatus from its normal position.

3.05 PIPING

- A. General: Comply with requirements of ANSI/NFPA 13 for installation of fire sprinkler piping products where indicated, in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that fire sprinkler piping complies with requirements and serves intended purposes.
- B. Arrange and install piping approximately as indicated; straight, plumb, and as direct as possible; form right angles on parallel lines with building walls. Keep pipes close to walls and avoid interference with other mechanical items. Locate groups of pipes parallel to each other; space at a distance to permit access for servicing valves. Most piping to be run in concealed locations unless indicated exposed, or in equipment rooms. Locate piping to avoid ductwork.
- C. Install horizontal piping as high as possible without sags or humps so that proper grades can be maintained for drainage. Install drain piping at low points of fire sprinkler piping.
- D. Install valved hose connections of sizes indicated, or 3/4" size if not otherwise indicated, on sprinkler at ends of branch lines and cross mains at locations where indicated.
- E. Install air vents at high points of sprinkler piping.
- F. Hangers and supports: Comply with NFPA for hanger materials
 1. Install standpipe system piping according to NFPA 14.
 2. Install sprinkler system piping according to NFPA 13.
- G. Grooved joints shall be installed in accordance with the manufacturer's latest published instructions. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service. Gaskets shall be molded and produced by the grooved coupling manufacturer. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Grooved coupling manufacturer's factory trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools, application of groove, and installation of grooved piping products. Factory trained representative shall periodically visit the jobsite to ensure best practices in grooved product installation are being followed. Contractor shall remove and replace any improperly installed products.

3.06 ADJUST AND CLEAN

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

3.07 FIELD QUALITY CONTROL

- A. Hydrostatic Testing: After flushing system, test fire sprinkler piping hydrostatically, for period of 2 hours, at not less than 200 psi or at 50 psi in excess of maximum static pressure when maximum static pressure is in excess of 150 psi. Check system for leakage of joints. Measure hydrostatic pressure at low point of each system or zone being tested.
- B. Repair or replace piping system as required to eliminate leakage in accordance with ANSI/NFPA standards for "little or no leakage", and retest as specified to demonstrate compliance.

3.08 EXTRA STOCK

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

END OF SECTION 21 10 00

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**SECTION 22 00 10
PLUMBING GENERAL PROVISIONS**

PART 1 - GENERAL

1.01 GENERAL

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

1.02 DESCRIPTION OF WORK

- A. This section applies to all work under the plumbing contract. This shall include, but not necessarily be limited to, the following:
 - 1. Waste and Vent Systems
 - 2. Hot and Cold Water Distribution System
 - 3. Plumbing Fixtures
 - 4. Sanitary Sewer
 - 5. Piping Insulation
- B. The work shall include all materials, equipment and labor required for complete and properly functioning plumbing systems.
- C. Drawings for plumbing work are in part diagrammatic, intended to convey the scope of work and indicate general arrangement of equipment, piping and approximate sizes and locations of equipment and materials.
- D. Where job conditions require reasonable changes in indicated locations and arrangements, make such changes without additional cost to Owner.
- E. Because of the scale of the drawings, certain piping or items such as unions or fittings may not be shown, but where such items are required by other sections of the specifications, or where they are required by the nature of the work, they shall be furnished and installed.
- F. All elements of the construction shall be performed by workmen skilled in the particular craft involved, and regularly employed in that particular craft.
- G. All work shall be performed in a neat, workmanlike manner in keeping with the highest standards of the craft.

1.03 CODES AND STANDARDS

- A. All work shall be done in accordance with the applicable portion of the following codes and standards:
 - 1. International Fire Suppression Code
 - 2. Uniform Plumbing Code
 - 3. International Building Code
 - 4. National Electric Code (NEC)
 - 5. National Fire Protection Association Standards (NFPA)
 - 6. Local Utility Company Requirements
 - 7. Local Codes, all trades
 - 8. Standards of ASME, ASHRAE, NEMA, IEEE, AGA, SMACNA
 - 9. Occupational Safety and Health Administration (OSHA)
 - 10. Underwriters Laboratories, Inc. (U.L.)
 - 11. Iowa Administrative Codes
 - 12. Americans With Disabilities Act (ADA)
 - 13. ANSI/NSF 372
- B. Contractors shall familiarize themselves with all codes and standards applicable to their work and shall notify Design Professional of any discrepancies between the design and applicable code requirements so that any conflicts can be resolved. Where two or more codes or standards are in conflict, that requiring the highest order of workmanship shall take precedence, but such questions shall be referred to Design Professional for final decision.

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

1.04 REQUIREMENTS & FEES OF REGULATORY AGENCIES

- A. Contractor shall comply with the rules and regulations of the authorities having jurisdiction and local utility companies. Contractor shall check with each utility company providing service to this project and determine or verify their requirements regarding incoming services.
- B. Meters for incoming services shall be selected based on the project requirements. Any questions concerning this shall be referred to Design Professional prior to bidding. Contractor shall provide the appropriate meter and associated materials if not furnished by the utility company.
- C. Secure all required permits and pay for all inspections, licenses and fees required in connection with the plumbing work. Contractor shall post all bonds and obtain all licenses required by the State, City, County and Utility.
- D. Contractor shall make all arrangements with each utility company and pay all service charges associated with new service.

1.05 PLUMBING DRAWINGS

- A. The plumbing drawings indicate in general the building arrangement only, Contractor shall examine construction drawings to familiarize himself with the specific type of building construction, i.e. type of structural system, floors, walls, ceilings, room finishes and elevations.
- B. Drawings are intended to convey the scope of the work and to indicate the general arrangement and locations of piping and equipment.
- C. Contractor shall layout his own work and shall be responsible for determining the exact locations for equipment and rough-ins and the exact routing of piping so as to best fit the layout of the work.
- D. Contractor shall take his own field measurements for verifying locations and dimensions: scaling of the drawings will not be sufficient for laying out the work.
- E. Because of the scale of the drawings, certain basic items such as pipe fittings and valves may not be shown, but where such items are required by code or by other sections of the specifications, such items shall be furnished and installed.

1.06 ACTIVE SERVICES

- A. Contractor shall be responsible for verifying exact location of all existing services prior to beginning work in that area.
- B. Existing active services, i.e., water, gas, sewer, electric, when encountered, shall be protected against damage. Do not prevent or disturb operation of active services which are to remain.
- C. When active services are encountered which require relocation, Contractor shall make request to authorities with jurisdiction for determination of procedures.
- D. Where existing services are to be abandoned, they shall be terminated in conformance with requirements of the authorities having jurisdiction.

1.07 SITE INSPECTION

- A. Contractor shall inspect the site prior to submitting bid for work to familiarize himself with the conditions of the site which will affect his work and shall verify points of connection with utilities, routing of outside piping to include required clearances from any existing structures, trees or other obstacles.
- B. Extra payment will not be allowed for changes in the work required because of Contractor's failure to make this inspection.

1.08 COORDINATION AND COOPERATION

- A. It shall be Contractor's responsibility to schedule and coordinate his work with the schedule of the General Contractor so as to progress the work expeditiously, and to avoid unnecessary delays.
- B. Contractor shall fully examine the drawings and specifications for other trades and shall coordinate the installation of his work with the work of the other contractors. Contractor shall consult and cooperate with the other contractors for determining space requirements and for determining that adequate clearance is allowed with respect to his equipment, other equipment and the building. Design Professional reserves the right to determine space priority of the contractors in the event of interference between piping, conduit, ducts and equipment of the various contractors.
- C. Drawings and specifications are intended to be complimentary. Any work shown in either of them, whether in the other or not, shall be executed according to the true intent and meaning thereof, the same as if set forth in all. Conflicts between the drawings and the specifications or between the requirements set forth for the various contractors shall be called to the attention of Design Professional. If clarification is not asked for prior to the taking of bids, it will be assumed that none is required and that Contractor is in agreement with the drawings and specifications as issued. If clarification is required after the contract is awarded, such clarification will be made by Design Professional and his decision will be final.
- D. Special care shall be taken for protection for all equipment. All equipment and material shall be completely protected from weather elements, painting and plaster until the project is substantially completed. Damage from rust, paint and scratches shall be repaired as required to restore equipment to original condition.
- E. Protection of all equipment during the painting of the building shall be the responsibility of the Painting Contractor, but this shall not relieve Contractor of the responsibility for checking to assure that adequate protection is being provided.
- F. Where the final installation or connection of equipment in the building requires Contractor to work in finished areas of the building, Contractor shall be responsible that such areas are protected and are not marred, soiled or otherwise damaged during the course of such work. Contractor shall arrange with the General Contractor for patching and refinishing of such areas which may be damaged in this respect.

1.09 OPENINGS, CUTTING AND PATCHING

- A. Piping and sleeves passing through all fire or smoke rated floors, roofs, walls, and partitions shall be provided with firestopping. Space between wall/floor and pipe and/or sleeve shall be sealed with UL listed intumescent fire barrier material equivalent to rating of wall/floor. Where piping and sleeves pass through floors, roofs, walls and partitions that are not fire or smoke rated, penetrations shall be sealed with grout or caulk.
- B. New structure:
 - 1. Contractor will coordinate the placing of openings and lintels in the new structure as required for the installation of the plumbing work with the General Contractor.
 - 2. Contractor shall furnish to General Contractor the accurate locations and sizes for required openings, but this shall not relieve Contractor of the responsibility of checking to assure that proper size openings are provided. When additional cutting and patching is required due to Contractor's failure to coordinate this work, Contractor shall make arrangements for the cutting, patching, and painting required.
- C. Existing Structure:
 - 1. Contractor shall provide cutting, lintels and patching, and patch painting in the existing structure, as required for the installation of his work, and shall furnish lintels and supports as required for openings.

2. Cutting of structural support members will not be permitted without prior approval of the Design Professional. Extent of cutting shall be minimized; use core drills, power saws or other machines which will provide neat, minimum openings.
3. Patching shall match adjacent materials and surfaces and shall be performed by craftsmen skilled in the respective craft required.

1.10 EXCAVATING AND BACKFILLING

- A. Contractor shall do all excavating necessary for sanitary sewers, storm sewers, water piping, gas piping, etc., and shall backfill trenches and excavations after work has been inspected. Care shall be taken in excavating that walls and footings and adjacent load bearing soils are not disturbed in any way, except where lines must cross under a wall footing. Where a line must pass under a footing, the crossing shall be made by the smallest possible trench to accommodate the pipe. Excavation shall be kept free from water by pumping if necessary.
- B. Backfill about the structure shall be placed, when practical, as the work of construction progresses. Backfilling on or against concrete work shall be done only when directed. Backfilling of trenches shall progress as rapidly as the testing and acceptance of the finished sections of the work will permit. Backfill shall be in accordance with Division 31 Specifications.

1.11 MATERIALS AND EQUIPMENT

- A. All materials and equipment shall be the standard product of a reputable U.S.A. manufacturer regularly engaged in the manufacture of the specified item. Where two or more units are required of the same item, they shall be furnished by the same manufacturer except where specified otherwise.
- B. All material and equipment shall be installed in strict accordance with the manufacturer's recommendations.
- C. The equipment specifications cannot deal individually with any minute items such as parts, controls, devices, etc., which may be required to produce the equipment performance and function as specified, or as required to meet the equipment guarantees. Such items, when required, shall be furnished as part of the equipment, whether or not specifically called for.

1.12 SUBMITTALS

- A. Contractor shall furnish, to Design Professional, complete sets of shop drawings and other submittal data. Contractor shall review and sign shop drawings before submittal. Refer to Division 01 specifications for additional requirements.
- B. Shop drawings shall be bound into sets and cover related items for a complete system as much as practical and shall be identified with symbols or "plan marks" used on drawings. Incomplete, piecemeal or unbound submittals will be rejected.
- C. Submittals required by the various sections of the Project Manual include, but are not necessarily limited to those identified in the submittal schedule below.
- D. After award of contract, Contractor shall provide a completed submittal schedule including dates that the submittals will be to Design Professional for review.
- E. Submit required information on the following items:

SPEC SECTION	EQUIPMENT	DETAIL DWGS	PROD DATA	SAMPLES	INSTALL METHODS	O & M MANUAL	CERTIFICATE OF SYSTEM DEMONSTRATION	OTHER (SEE NOTES)
22 05 19	Meters and Gages for Plumbing Piping		X					
22 05 23	General Duty Valves for Plumbing Piping		X					
22 05 53	Plumbing Identification		X					
22 07 00	Plumbing Insulation		X					

SPEC SECTION	EQUIPMENT	DETAIL DWGS	PROD DATA	SAMPLES	INSTALL METHODS	O & M MANUAL	CERTIFICATE OF SYSTEM DEMONSTRATION	OTHER (SEE NOTES)
22 11 23	Domestic Water Pumps		X			X	X	
22 14 29	Sump Pumps		X			X		
22 40 00	Plumbing Fixtures		X			X		
22 45 00	Emergency Plumbing Fixtures		X			X		
22 47 00	Drinking Fountains and Water Coolers		X			X		

- F. Design Professional will review shop drawings solely to assist contractors in correctly interpreting the plans and specifications.
- G. Contract requirements cannot be changed by shop drawings which differ from contract drawings and specifications.

1.13 OPERATION AND MAINTENANCE MANUALS

- A. Operation and maintenance manuals shall be submitted to Design Professional in duplicate upon completion of the job. Refer to Division 01 specifications for additional information.
- B. Submit manuals in duplicate upon completion of the job. Manuals shall be bound in a three ring hard-backed binder. Front cover and spine of each binder shall have the following lettering done:

OPERATION
AND
MAINTENANCE
MANUAL
FOR
PLUMBING SYSTEMS

(PROJECT NAME)
(LOCATION)
(DATE)

SUBMITTED BY
(NAME AND ADDRESS OF CONTRACTOR)

- C. Provide a master index at the beginning of manual showing items included. Use plastic tab indexes for sections of manual. Each section shall contain the following information for equipment furnished under this contract:
 1. Equipment and system warranties and guarantees.
 2. Installation instructions.
 3. Operating instructions.
 4. Maintenance instructions.
 5. Spare parts identification and ordering list.
 6. Local service organization, address, contract and phone number.
 7. Shop drawings with reviewed stamp of Design Professional and Contractor shall be included, if applicable, along with the items listed above.
 8. Reports of all tests and demonstrations including certificate of owner instruction, testing and balancing report, etc.

1.14 TESTS AND DEMONSTRATIONS

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

System	Pressure
Domestic Water Piping Systems	Refer to Section 22 1116 – Domestic Water Piping
Soil, Waste, Storm Drainage Piping Below Grade	10 feet waterhead or fill to top of vent outlet above roof.
Soil, Waste, Storm Drainage Piping Above Grade	Fill piping with water to top of vent outlet above roof, or 10 feet waterhead.

TESTING NOTE: All rubber gasket joints for cast iron soil pipe and fittings should be properly restrained if test pressures exceed 10 feet of head.

- B. All systems shall be tested by Contractor and placed in proper working order prior to demonstrating systems to Owner. Contractor shall submit a report to Design Professional citing dates, times, pressures, and results of all tests performed.

1.15 TRAINING AND DEMONSTRATIONS

- A. Prior to acceptance of the plumbing installation, Contractor shall provide to Owner, or his designated representatives, all comprehensive training on essential features and functions of all systems installed, and shall instruct Owner in the proper operation and maintenance of such systems.
 - 1. Provide adequate notice to Owner as to when instruction will be conducted so appropriate personnel can be present.
 - 2. Prepare the instruction format for a minimum of four Owner Representatives.
- B. Equipment training:
 - 1. Manufacturer's representatives shall provide instruction on each major piece of equipment. Contractor shall provide instruction on all other equipment.
 - 2. Training sessions shall use the printed installation, operation and maintenance instruction materials included in the O&M manuals and emphasize preventative maintenance and safe operating procedures.
 - 3. Training shall be performed by qualified factory trained technicians.
 - 4. Plumbing Contractor shall attend all sessions performed by the manufacturer's representative and shall add to each session any special information relating to the details of installation of the equipment as it might impact the operation and maintenance.
 - 5. Equipment training shall occur as soon as possible after start up of the equipment and shall include hands-on operation. Training shall be provided for equipment listed in the table below.
- C. System training:
 - 1. These sessions shall include hands-on demonstrations of system wide start-up, operation in all possible modes, shut-down and emergency procedures.

D. The following are minimum requirements for Owner instruction:

Section	Description	Hours (Note 1)	Presented By	Others Present	Remarks
22 00 10	Plumbing System (Excluding Equipment)	8	Contractor		Note 2
22 33 00 22 34 00	Water Heaters	4	Manufacturer's Representative	Contractor	
22 11 23	Plumbing Pumps	2	Manufacturer's Representative	Contractor	
1. Any unused hours shall be used at Owner's discretion during the first year of occupancy. 2. System training shall include, but not be limited to, valve locations, system routing, and air/water flow patterns, system start-up/shut-down/emergency procedures.					

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

CERTIFICATE OF SYSTEM DEMONSTRATION

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

- A. Project:
- B. System(s):
- C. Contractor's representatives giving instruction and demonstration:

Contractor: _____

NAMES	DATE	HOURS

- D. Owner's representatives receiving instruction:

Owner: _____

NAMES	DATE	HOURS

- E. Acknowledgement of demonstration:

Contractor's Representative:

Signature

date

Owner's Representative:

signature

date

1.16 SUBSTITUTIONS

- A. Refer to Divisions 00 and 01. Refer to Section 01 25 00 – Substitution Procedures.
- B. Where substitutions are approved, Contractor assumes all responsibility for physical dimensions and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of the substitution.

1.17 ACCEPTABLE MANUFACTURERS

- A. In most cases, equipment specifications are based on a specific manufacturer's type, style, dimensional data, catalog number, etc. Listed with the base specification, either in the manual or on the plan schedules are acceptable manufacturers approved to bid products of equal quality. These manufacturers are encouraged to submit to Design Professional at least 8 days prior to the bid due date drawings and catalog numbers of products to be bid as equals.
- B. Manufacturers who do not submit prior to bidding, run the risk of having the product rejected at time of shop drawing submittal. Extra costs associated with replacing the rejected product shall be the responsibility of Contractor and/or the manufacturer.
- C. If Contractor chooses to use a manufacturer listed as an equal, it shall be his responsibility to assure that the manufacturer has complied with the requirements in 'A' above. Contractor shall assume all responsibility for physical dimensions (including accessibility for maintenance), operating characteristics, and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of using the alternate manufacturer.
- D. Where a model or catalog number is provided, it may not be inclusive of all product requirements. Refer to additional requirements provided on the plans or in the specifications as required. Similarly, there may be additional requirements included in the model or catalog number that are not specifically stated. These requirements shall also be met.

1.18 WARRANTY

- A. Refer to Divisions 00 and 01 for information on warranties and correction of work within the warranty period.
 - 1. If a warranty or warranty period are not defined in Division 00 or 01, then the start of all warranty periods shall be the date of Substantial Completion and the length of the warranty shall be for one year.
 - a. If construction is phased with distinct and separate Substantial Completion dates for portions of the building and/or systems, separate warranties shall be provided for each of these phased areas and/or systems.
 - b. The entire Plumbing system, including all sub-systems, shall be guaranteed against defect in materials and installation for the duration of the warranty period. Any malfunctions or defects which occur within the warranty period shall be promptly corrected without cost to the Owner. This guarantee shall not limit or void any manufacturer's express or implied warranty.
- B. Refer to other Division 22 sections for systems, equipment, or material requiring extended warranties.
- C. The date of systems/equipment startup or equipment/material shipment to the site shall not be considered the notable date with relation to the warranty of that item. All systems, equipment, material, etc., shall have the same start date with respect to the warranty period.
- D. Systems, equipment or material put into use to facilitate construction activities (e.g. testing and balancing, commissioning, temporary conditioning, etc.) prior to the start of the warranty period shall not impact the length of the warranty in any way.

1.19 COMPLETION

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

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

1.20 CLEANING

- A. At the conclusion of the construction, the entire system of piping and equipment shall be cleaned internally.
- B. All temporary labels, stickers, etc., shall be removed from all fixtures and equipment. Name plates, ratings, instruction plates, etc., shall not be obscured by paint, insulation, or placement of units.
- C. Before being placed in service, all domestic water distribution systems, including those for cold water and hot water shall be chlorinated as required per Section 22 1116 - Domestic Water Piping.

1.21 ELECTRICAL WORK

- A. Electrical work and equipment provided by Contractor shall include the following:
 - 1. Starters and disconnects for motors of plumbing equipment, but only where specifically indicated to be furnished integrally with equipment.
 - 2. Wiring from motors to disconnect switches or junction boxes for motors of plumbing equipment, but only where specifically indicated to be furnished integrally with equipment.
 - 3. All control wiring in accordance with the requirements of Division 26.
- B. Electrical Contractor shall provide all power wiring for plumbing equipment, including services for motors and equipment furnished by the plumbing contractor. Motor and equipment locations are shown on the electrical drawings.
- C. Electrical Contractor shall make final connections for all motors and equipment furnished by the plumbing contractor.
- D. Electrical Contractor shall furnish safety disconnects and starters for all motors and equipment furnished by the plumbing contractor (unless specifically indicated to be furnished integrally with the equipment), so as to make service complete to each item of equipment.
- E. Contractor shall consult with Electrical Contractor prior to conduit rough-in and shall verify with him the exact locations for rough-ins, and the exact size and characteristics of the services required, and shall provide Electrical Contractor a schedule of electrical loads for the equipment furnished by him. These schedules will be used for sizing services, disconnects, fuses, starters and overload protection.

1.22 TEMPORARY UTILITIES

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

END OF SECTION 22 00 10

SECTION 22 05 00
COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.01 GENERAL

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

1.02 DESCRIPTION OF WORK

- A. This section includes the following:
 - 1. Demolition
 - 2. Sleeves
 - 3. Escutcheons
 - 4. Fire Stopping
 - 5. Guards

PART 2 - PRODUCTS

2.01 DEMOLITION MATERIALS

- A. All materials removed shall be the property of the removing contractor and shall be removed from the site by him, unless otherwise specified.

2.02 SLEEVES

- A. Sleeves passing through non load bearing walls and partitions shall be galvanized sheet steel with lock seam joints of minimum gauges as follows:
 - 1. For pipes 2 1/2" and smaller 24 gauge
 - 2. For pipes 3" to 6" 22 gauge
 - 3. For pipes over 6" 20 gauge
- B. Sleeves passing through load bearing walls, concrete beams, fireproof walls, foundations, footings and waterproof floors shall be Schedule 40 steel pipe or cast iron pipe.
- C. Sleeves are not required in masonry walls which are core drilled or walls of drywall construction, except where partition is a firestop, smokestop, or side of air plenum.
- D. Sleeves for insulated piping shall be of sufficient internal diameter to take pipe and insulation and to allow for free movement of pipe. Waterproof sleeves shall be of sufficient internal diameter to take pipe and waterproofing material.
- E. In finished areas where pipes are exposed, sleeves shall be terminated flush with wall, partitions and ceilings, and shall extend 1/2" above finished floors. Extend sleeves 1" above finished floors in areas likely to entrap water and fill space between sleeves and pipe with graphite packing and caulking compound.
- F. Sleeves passing through membrane waterproofing or lead safe shall be provided with flashing, furnished and installed by General Contractor, extending 12" beyond sleeve in all directions; flashing shall be secured and sealed to membrane or lead safe and shall be sealed to sleeve and caulked watertight. Sleeves passing through roof shall be installed in same manner except sleeves shall extend to 6" above roof.
- G. For exterior walls below grade, sleeves shall be cast iron. Space between sleeve and pipe shall be sealed with modular rubber links tightened with bolts (Link-Seal or equal). Waterproofing of pipe penetrations in exterior walls shall be coordinated with waterproofing contractor.

2.03 ESCUTCHEONS

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

2.04 FIRESTOPPING

- A. Piping, sleeves and ducts passing through all fire or smoke rated floors, roofs, walls, and partitions shall be provided with firestopping. Space between wall/floor and pipe, sleeve, and/or duct shall be sealed with UL Listed intumescent fire barrier material equivalent to rating of wall/floor. Refer to Section 07 84 00 – Firestopping for additional information.

PART 3 - EXECUTION

3.01 DEMOLITION

- A. General:
 - 1. Demolition shall be accomplished by the proper tools and equipment for the work to be removed. Personnel shall be experienced and qualified in the type of work to be performed.
 - 2. Contractor shall remove existing equipment and piping not necessary for additions or existing portions of building as indicated on drawings and/or specified herein. To include all abandoned equipment and piping back to point of origin. Demolition of equipment shall include removal of associated concrete equipment pad and/or support steel.
 - 3. Contractor shall be responsible for the cutting and capping of all existing services before any work is commenced by the General Contractor.
- B. Work by Others: Unless specifically noted under other contracts, Contractor shall assume all required work shall be performed by him. In general, the following will be performed by others:
 - 1. General Contractor will remove any floors, walls and ceilings, neatly patch, match, complete and finish all affected surfaces.
 - 2. Electrical Contractor will disconnect all electrical services and remove abandoned conduit back to point of origin.
- C. Existing Conditions:
 - 1. If any piping serving existing fixtures or equipment which are to remain are disturbed by operations under this Contract, Contractor shall provide pipe and insulation required to reestablish continuity of such piping systems.
 - 2. Contractor shall arrange for General Contractor to repair, patch and paint all construction, with material necessary to match surrounding material, which is necessary due to removal of equipment and piping.
 - 3. Contractor shall furnish all required labor and material where required to extend new work to connect to similar work where new addition adjoins existing building and for extension of existing system. Connection shall be made in a suitable manner.
- D. Owner's Right of Salvage: The Owner may designate and have salvage rights to any material herein demolished by the Contractor.

3.02 SLEEVES

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

3.03 ESCUTCHEONS

- A. Install escutcheons for all pipes entering finished spaces.

3.04 GUARDS

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

3.05 ACCESS DOORS

- A. Install access doors per manufacturer's recommendations.

END OF SECTION 22 05 00

SECTION 22 05 19
METERS AND GAUGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED WORK

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

1.02 DESCRIPTION OF WORK

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

1.03 SUBMITTALS

- A. Submit manufacturer's catalog cuts showing complete descriptive data.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Thermometers
 1. Weiss 9VU35 with lead free thermowell (Base Specification)
 2. Taylor
 3. Weksler
 4. U.S. Gauge
 5. Terice
- B. Gauges (For Water)
 1. Weiss Series LF402 (Base Specification)
 2. Dwyer
 3. Taylor
 4. Weksler
 5. U.S. Gauge
 6. Terice

2.02 THERMOMETERS

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

2.03 GAUGES

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

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install thermometers in discharge and return piping at water heaters and at other points as indicated on the drawings.
- B. Provide a 1/4" ball valve upstream of all gauges.
- C. Install gauge for each pump, mounted on 1/4" copper tube pipe manifold connected to the suction and discharge of the pump, with ball valves in the manifold on each side of the gauge, so that the gauge may be opened to either the suction or discharge pressure.
- D. Install gauges at pressure reducing valves and at other points as indicated on drawings.

END OF SECTION 22 05 19

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SECTION 22 05 23
GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED WORK

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

1.02 DESCRIPTION OF WORK

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

1.03 SUBMITTALS

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

1.04 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Gate Valves and Check Valves
 1. NIBCO
 2. Powell
 3. Milwaukee
 4. Watts
 5. Clow
- B. Lugged Body Butterfly Valves
 1. NIBCO
 2. ABZ
 3. Milwaukee
 4. Watts
- C. Ball Valves
 1. Watts LFB-6080/6081
 2. Milwaukee UPBA-400S/450S
 3. NIBCO T/S-585-66 LF
 4. Apollo 77CLF-140/240
- D. Domestic Hot Water Recirculation Balancing Valves
 1. Taco
 2. Bell & Gossett
 3. Wheatley
 4. Armstrong
 5. Flow Design Inc. (Flow Set)
 6. Griswold
 7. NIBCO
- E. All valves of same type shall be of the same manufacturer unless otherwise specified in this section or on the drawings.
- F. Model numbers in valve schedule based on NIBCO, unless noted otherwise.

2.02 VALVE CONSTRUCTION

- A. Gate valves shall have solid tapered wedge, except where otherwise specified.
- B. Check Valves: 2" and smaller, horizontal swing type with Teflon seat, bronze lead free body. 200 psi, CWP and 300 deg. F maximum temperature. 2-1/2" and larger, flanged silent check type with bronze mounted bolted bonnet and renewable seat and disc, ductile iron body, 150 psi at 366 deg F conforming to MSS SP-136.
- C. Ball Valves 4" and smaller: Bronze or brass two-piece with stainless steel ball, teflon seats and stuffing box ring, vinyl insulated lever handle.
 - 1. Full port for valves 2-1/2" and smaller.
 - 2. Standard port for valves 3" and larger.
- D. Domestic hot water recirculation balancing valves: Bell & Gossett Model CB "Circuit Setter" or equal.
 - 1. Ball type valve with brass body and stainless-steel ball construction, glass and carbon fitted TFE seat rings, extended readout ports with integral check valves and gasketed caps, drain port, calibrated nameplate and position indicator, memory stops, and NPT connectors, rated for 300 psig at 250°F.
 - 2. Valves to seal leak-tight at maximum rated working pressure.
 - 3. Valves to be selected for 5 ft. pressure drop at full open setting and design water flow.
- E. Butterfly Valves 3" and Larger: ASTM A536 ductile iron body with aluminum bronze disc, EPDM or BUNA N seat, 416 stainless steel stem with extended neck.

2.03 VALVE SCHEDULE

- A. Furnish valves as per the following schedule:

<u>Service</u>	<u>Valve type</u>
Building domestic and industrial water, before and after meter	Gate - 2" and larger, Clow – epoxy coated, resilient seated, full port OS&Y
Domestic hot and cold-water pressures up to 200 psi	Ball - 2-1/2" and smaller, S-FP600A-LF Ball - 3" and 4", T-FP600A-LF Butterfly – 3" and larger, LD-2000 Check - 2" and smaller, T/S413Y-LF 2-1/2" and larger, 910-LF
Domestic hot water recirculation valves	All sizes – Bell & Gossett Model CB circuit setter.

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

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install valves in accessible location in general locations indicated on the drawings and as called for in other sections.
- B. Install valves in equipment rooms to provide easy access to valve. Each valve installed 8'-0" above the floor shall be provided with chain operator. Bottom of chain operator shall be 7'-0" above floor.
- C. Check valves shall not be installed in vertical runs of piping unless they are specifically designed for vertical operation.
- D. Gate valves shall be installed in horizontal pipes with the valve stem in the vertical up position. Rotate valve stem only as allowed by the manufacturer's installation instructions.

END OF SECTION 22 05 23

SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED WORK

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

1.02 DESCRIPTION OF WORK

- A. Provide materials, equipment, labor and supervision necessary to install hangers, supports, anchors, guides and seals as required by the drawings and this section.
- B. Types of supports, anchors and seals specified in this section include the following:
 - 1. Horizontal Piping Hangers and Supports.
 - 2. Vertical Piping Clamps.
 - 3. Hanger Rod Attachments.
 - 4. Building Attachments.
 - 5. Saddles and Shields.
 - 6. Miscellaneous Materials.
 - 7. Anchors.

1.03 QUALITY ASSURANCE

- A. Code Compliance: Comply with applicable plumbing and mechanical codes pertaining to product materials and installation of supports, anchors and seals.
- B. UL and FM Compliance: Provide products which are Underwriters Laboratories listed and Factory Mutual approved.
- C. ANSI Compliance: All supports and parts shall conform to the latest requirements of the ANSI Code for Pressure Piping B31.1.0 except as supplemented or modified by the requirements of this specification.

PART 2 - PRODUCTS

2.01 HANGERS, SUPPORTS AND ACCESSORIES (Reference Catalog Figure numbers from Anvil)

- A. Pipe support systems shall secure pipes in place, prevent pipe vibration, provide vertical adjustment for maintaining required grades, and provide for expansion and contraction.
- B. Pipe hangers shall be capable of supporting the pipe in all conditions of operation. They shall allow free expansion and contraction of the piping, and prevent excessive stress resulting from transferred weight being induced into the pipe or connected equipment.
- C. Wherever possible, pipe attachments for horizontal piping shall be pipe clamps.
- D. Wherever possible, structural attachments shall be beam clamps.
- E. All rigid hangers shall provide a means of vertical adjustment after erection.
- F. Hanger rods shall be subject to tensile loading only. At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit swing.
- G. Where horizontal piping movements are greater than 1/2 inch, or where the hanger rod angularity from the vertical is greater than 4 degrees from the cold to hot position of the pipe, the hanger pipe and structural attachments shall be offset in such manner that the rod is vertical in the hot position.
- H. Hangers shall be designed so that they cannot become disengaged by movements of the supported pipe.
- I. Where supports are attached to concrete or other structural members, care shall be taken to prevent damage or weakening of the structural members.

- J. Where concrete inserts are used, it shall be the Contractor's responsibility to accurately locate and attach inserts to concrete forms.
- K. Hangers and supports that are in direct contact with copper piping shall be copper plated or have nonmetallic coating for electrolytic protection.

PART 3 - EXECUTION

3.01 INSTALLATION HORIZONTAL PIPE SUPPORT

- A. Steel and stainless-steel pipe shall be supported at a maximum span of 10 feet for all pipe sizes, with hanger rods sized accordingly for total supported weight.
- B. Copper pipe shall be supported at a maximum length of 6 feet for pipe sizes up through 1-1/2" and at a maximum length of 10 feet for pipe sizes 2" and larger with hanger rods sized accordingly for the total supported weight.
- C. PVC and CPVC pipe shall be supported at a maximum span of 3 feet for pipe sizes up through 1" and at a maximum span of 4 feet for pipe sizes 1-1/4" and larger with hanger rods sized accordingly for total supported weight.
- D. PEX tubing and Polyethylene pipe shall be supported at a maximum span of 32" with hanger rods sized accordingly for the total supported weight.
- E. Cast Iron soil pipe shall be supported with one hanger for each section of pipe (maximum 10' span) with hanger rods sized accordingly for the total supported weight. Locate hangers within 18" of hub or joint.
- F. In addition to the above specified spacings, install additional hangers at change in pipe direction and at concentrated loads, large valves, strainers, etc.
- G. When two or more pipes are to be run parallel together, they may be supported on trapeze type hangers. Trapeze bar angles or channels and hanger rods shall be of sufficient size with required spacing to support the particular group of pipes.
- H. For suspending hanger rods from brackets attached to walls; use welded steel brackets, Fig 194 for loads up to 750 lbs; Fig. 195 for loads up to 1,500 lbs; Fig. 199 for loads up to 3000 lbs.
- I. Where pipes are to be racked along walls, use malleable iron one hole clamp, Fig. 126 for pipes up to 3". For pipes larger than 3", use steel channel strut pipe rack.
- J. Where pipes are to be supported from floor, use unistrut pipe stand with post base. Unformed concrete will not be permitted.
- K. Hangers and supports for insulated cold piping shall not injure or pierce insulation. Provide insulation protection shields or saddles for piping, (Fig. 167) in conjunction with hanger or roll device

3.02 INSTALLATION VERTICAL PIPE SUPPORTS

- A. Support vertical steel and copper pipe at every other floor line.
- B. Support vertical cast iron soil pipe at every floor line.
- C. In addition to the above, support vertical pipes at base of riser with base fitting set on concrete or block pier, or by hanger located on horizontal connection close to riser.
- D. Where pipe sleeves extend above floor, place pipe clamps at ceiling below and support clamp extensions from inserts or other approved attachment.

3.03 PIPE ATTACHMENTS

- A. For horizontal steel pipe, use adjustable carbon steel clevis, Fig. 260, for pipes up to 30".
- B. For horizontal copper pipe and tube, use copper plated adjustable carbon steel clevis, Fig. CT 65.
- C. When thermal expansion for horizontal pipe is in excess of 1/2" axially as indicated on the drawing, use adjustable steel yoke pipe roll, Fig. 181, or pipe roll stand, Fig. 177.

3.04 INTERMEDIATE ATTACHMENTS

- A. Hanger rods: use carbon steel single or double end threaded, Figs. 140 and 253 as required. Continuous threaded rod, Fig. 146, may be used wherever possible. Contractor may at his option cut and thread rod on the job site.
- B. Chain, wire or perforated strap hangers will not be permitted. One pipe shall not be suspended from another pipe.
- C. Hangers shall be supported from appropriate structural members. In no case shall hangers be supported from ductwork, cable trays, piping, or other equipment. Existing hangers and supports shall not be used as supports for new hangers unless specifically designed as such, or additional loadings have been confirmed to be acceptable for existing supports.

3.05 STRUCTURAL ATTACHMENTS

- A. For attaching steel or copper plated hanger rods to reinforced concrete; use black carbon steel concrete inserts, Fig. 285 for loads up to 400 lbs., Fig. 281 for loads up to 1200 lbs. or suitable drilled inserts equal to Ramset/Red Head - Trubolt wedge anchor, Ramset/Red Head Epcn system or Hilti Kwik Bolt II anchor.
- B. For attaching steel hanger rods to structural steel beams, use malleable iron C clamps, Fig. 87, with retaining clip for loads up to 500 lbs.; Fig. 229 with extension piece for loads up to 1,365 lbs. For copper plated hanger rods, use copper plated malleable iron C clamps, Fig. CT 88, with hardened cup point set screw, for loads up to 400 lbs.
- C. For attaching steel hanger rods to wood structural members, use malleable iron ceiling flange pipe threaded, Fig. 128 for loads up to 480 lbs., Fig. 153 for loads up to 1270 lbs. For copper plated hanger rods, use copper plated malleable iron ceiling flange, Fig. CT 128R for loads up to 180 lbs.
- D. Under no circumstances shall hangers be attached to metal roof deck.

3.06 PIPE COVERING PROTECTION

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

3.07 ROOF MOUNTED PIPING AND EQUIPMENT

- A. Roof mounted equipment, not specified to be mounted on roof curbs, shall be installed on equipment mounting rails specifically designed for that purpose or as shown on plans.
- B. Roof mounted piping shall be mounted on a pipe support system equal to B-Line C-Port.

END OF SECTION 22 05 29

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SECTION 22 05 53
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED WORK

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

1.02 DESCRIPTION OF WORK

- A. Extent of plumbing identification work required by this section is indicated on drawings and/or specified in other Division 22 sections.
- B. Type of identification devices specified in this section include the following:
 - 1. Painted identification materials
 - 2. Plastic pipe markers
 - 3. Plastic tape
 - 4. Valve tags
- C. Identification furnished as part of factory fabricated equipment, is specified as part of the equipment assembly in other Division 22 sections.

1.03 QUALITY ASSURANCE

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

1.04 SUBMITTALS

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

PART 2 - PRODUCTS

2.01 IDENTIFICATION MATERIALS

- A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 22 sections. Where more than one single type is specified for an application, selection is Installer's option, but provide single selection for each product category.
- B. Painted Identification Materials:
 - 1. Stencils: Standard fiberboard stencils, prepared for required applications with letter sizes generally complying with recommendations of ANSI A13.1 for piping and similar applications, but not less than 3/4" high letters for access door signs and similar operational instructions.
 - 2. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray can form and grade.
 - 3. Identification Paint: Standard identification enamel of colors indicated, or, if not otherwise indicated for piping systems, comply with color chart below for colors.
- C. Plastic Pipe Markers:
 - 1. General: Provide manufacturer's standard pre-printed flexible or semi rigid, permanent, color coded, plastic sheet pipe markers.

2. Color: Color of pipe markers shall comply with ANSI A13.1.
 3. Small Pipes: For external diameters not greater than 6" (including insulation if any), provide full band pipe markers extending 360 degrees around pipe at each location, fastened by one of the following methods:
 - a. Snap on application of pre tensioned semi rigid plastic pipe marker.
 - b. Adhesive lap joint in pipe marker overlap.
 - c. Laminated or bonded application of pipe marker to pipe (or insulation).
 - d. Taped to pipe (or insulation) with color coded plastic adhesive tape, not less than 3/4" wide full circle at both ends of pipe marker, tape lapped 1 1/2".
 4. Large Pipes: For external diameters of 6" and larger (including insulation if any), provide either full band or narrow strip type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:
 - a. Laminated or bonded application of pipe marker to pipe (or insulation).
 - b. Taped to pipe (or insulation) with color coded plastic adhesive tape, not less than 1 1/2" wide; full circle at both ends of pipe marker, tape lapped 3".
 - c. Strapped to pipe (or insulation) application of semi rigid type, with manufacturer's standard stainless-steel bands.
 5. Lettering: Manufacturer's standard preprinted nomenclature which best describes piping system in each instance, as selected by Design Professional in cases of variance with names as shown or specified.
 6. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as a separate unit of plastic.
- D. Plastic Tape:
1. General: Manufacturer's standard color-coded pressure sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.
 - a. Width: Provide 1 1/2" wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6", 2 1/2" wide tape for larger pipes.
 - b. Color: Comply with color selection indicated for Plastic Pipe Markers.
- E. Valve Tags:
1. Brass Valve Tags: Provide polished brass valve tags with stamp engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 7/16" high, and with 3/16" hole for fastener. Tag thickness 0.040 inches.
 - a. Provide 2" diameter tags, except as otherwise indicated.
 - b. Fill tag engraving with black enamel.
 2. Plastic Valve Tags: Provide red heavy plastic tag with 7/16" white embossed sequenced numbers.
 3. Valve Tag Fasteners: Manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S hooks or heat-sealed braided copper wire of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
- F. Name Plates:
1. General: Provide manufacturer's standard preprinted plastic, brass, or aluminum with stamped, engraved or embossed letters.
 2. Lettering:
 - a. Large Equipment: 1 1/2" lettering as appropriate.
 - b. Small Equipment: 3/4" lettering as appropriate.
 3. Attachments: Mounting holes and screws, pressure sensitive adhesive backing, or solid brass chain.

2.02 LETTERING AND GRAPHICS

- A. General: Coordinate names, abbreviations and other designations used in plumbing identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of plumbing systems and equipment.
 - 1. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Boiler No. 3, Air Supply No. 1H, Standpipe F12).

PART 3 - EXECUTION

3.01 APPLICATION AND INSTALLATION

- A. General Installation Requirements:
 - 1. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish including valve tags, install identification after completion of covering and painting if any. Install identification prior to installation of acoustical ceilings and similar concealment.
- B. Piping System Identification:
 - 1. General: Install pipe markers of one of the following types on each piping system, and include arrows to show normal direction of flow:
 - a. Stenciled markers, including color coded background band or rectangle, and contrasting lettering of black or white. Extend color band or rectangle 2" beyond ends of lettering.
 - b. Plastic pipe markers, with application system as indicated under "Materials" in this section.
 - c. Stenciled markers, black or white for best contrast, wherever continuous color coded painting of piping is provided.
 - 2. Locate pipe markers and color bands as follows wherever piping is exposed to view in unoccupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non concealed locations. Install all markers such that lettering is visible from the floor.
 - a. Near each valve and control device.
 - b. Near each branch, excluding short take offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
 - c. Near locations where pipes pass through walls or floors/ceilings, or enter non accessible enclosures.
 - d. At access doors, manholes and similar access points which permit view of concealed piping.
 - e. Near major equipment items and other points of origination and termination.
 - f. Spaced intermediately at maximum spacing of 20' along each piping run with a minimum of one marker in each room.
 - g. On piping above removable acoustical ceilings.
- C. Valve Identification:
 - 1. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory fabricated equipment units, plumbing fixture faucets, convenience and lawn watering hose bibs, and shut off valves at plumbing fixtures and similar rough in connections of end use fixtures and units. List each tagged valve in valve schedule for each piping system.
- D. Equipment Identification:
 - 1. General: Provide equipment identification for all equipment including water heaters, heat exchangers, water softeners, and pumps.
 - 2. Labeling: All equipment shall be labeled as per construction document plan marks or as designated by Owner.

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

END OF SECTION 22 05 53

SECTION 22 07 00
PLUMBING INSULATION

PART 1 - GENERAL

1.01 RELATED WORK

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

1.02 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary to install insulation to all hot and cold surfaces of piping, tanks, fittings and other surfaces as required by the drawings and this section.
- B. Insulation shall include insulating materials, jackets, adhesive, mastic coatings, tie wire and other materials as required to complete the insulating work.

1.03 QUALITY ASSURANCE

- A. NFPA Compliance: Insulating materials, jackets, mastics, etc., shall meet flame spread and smoke developed ratings in accordance with NFPA-90A. Flame spread rating of not more than 25, smoke developed rating of not more than 50 as tested by ANSI/ASTM E84 (UL 723) (NFPA 255) method. All accessory items such as PVC jacketing and fittings, adhesive, mastic, cement tape and cloth shall have the same component ratings as specified above.
- B. Installation of insulation materials shall be in accordance to the latest edition of MICA/NIAC National Commercial & Industrial Standards for the appropriate material application.

1.04 SUBMITTALS

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

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard ratings of products.
- B. Protect insulation against dirt, water, and chemical and plumbing damage. Do not install damaged insulation; remove from project site.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Insulating Materials
 1. Owens/Corning Fiberglass Corp.
 2. Armacell
 3. Pittsburgh Corning Corp.
 4. CertainTeed Corp.
 5. Knauf Fiber Glass
 6. John's-Manville Corp.
 7. Aeroflex
- B. Mastics and adhesives as recommended by insulation manufacturer.

2.02 PIPE INSULATION

- A. Type 'A': Preformed sectional heavy density fiberglass insulation and factory applied vapor barrier, all service jacket with pressure sensitive self-sealing longitudinal laps and butt strips. Suitable for operating temperatures from 0 to +850 deg. F. Thermal conductivity shall be no more than 0.23 Btu-in/hr-sq.ft.-deg F @ 75 deg. F mean temperature. Water vapor permeance of .02 perms. Equal to Owens Corning 25 ASJ/SSL.
 1. Where insulation is exposed to weather outdoors it shall be covered with an aluminum or stainless steel weatherproof jacket 0.016" thick and sealed.

2. Where insulation is exposed in indoor occupied space and within 8 feet of finished floor, it shall be covered with 30 mil PVC jacket equal to Johns Manville Zeston.
 3. Where insulation is exposed in a mechanical room and is within 6 feet of finished floor, it shall be covered with a 0.016" aluminum jacket.
- B. Type 'B': Flexible elastomeric extruded pipe covering, 6 pound density, 0.27 K factor, water vapor permeance of 0.20 perms. Suitable for temperature from -40 deg. F to +220 deg. F. Equal to Armacell, AP Armaflex, joints sealed with adhesive as recommended by insulation manufacturer.
1. Where insulation is exposed to weather outdoors it shall be covered with an aluminum or stainless steel weatherproof jacket 0.016" thick and sealed.
 2. Where insulation is exposed in indoor occupied space and within 8 feet of finished floor, it shall be covered with 30 mil PVC jacket equal to Johns Manville Zeston.
 3. Where insulation is exposed in a mechanical room and is within 6 feet of finished floor, it shall be covered with a 0.016" aluminum jacket.

2.03 FITTING INSULATION

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

2.04 EQUIPMENT INSULATION

- A. Type 'G':
1. Rigid fiberglass insulation board with factory applied all service jacket. Suitable for operating temperatures of 0 to +850 deg. F. Water vapor permeance of .02 perms. Equal to Owens Corning Series 700 with 25 ASJ facing.
 2. Cut or miter insulation where necessary to fit the shape and contour of the equipment. On round surfaces band insulation in place with 3/4" x 0.015" thick galvanized steel bands 18" on center. On flat or irregular surfaces impale insulation over welded pins on 12" centers and secure with speed washers.
 3. Apply vapor seal ASJ pressure-sensitive patches at damaged areas. All insulation edges and butt joints are to be sealed with pressure-sensitive joint sealing tape to match the jacket. Apply in accordance with manufacturers recommendations.
- B. Type 'I':
1. Flexible elastomeric insulation. Suitable for operating temperatures of -40 to +220 deg. F. Equal to Armacell Armaflex II Sheet Insulation.
 2. Cut insulation where necessary to fit the shape and contour of the equipment. Insulation shall be installed using Armacell 520 Adhesive.
 3. Exposed outdoor insulation shall be finished with two coats of Armacell Armaflex finish.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Use only experienced applicators regularly engaged in the trade. Rough work will be rejected. Application details shall be in accordance with the insulating materials supplier's recommendations except where a higher standard is specified. All surface finishes shall be extended in such a manner as to protect all raw edges, cuts and surfaces of insulation.
- B. Do not insulate the following:
1. Valve bonnets
 2. Unions in hot piping
 3. Preinsulated expansion joints

- C. Inspect all piping and equipment before applying insulation to ensure the installing contractor has completed all leak tests, and that all surfaces are clean, dry and ready for application of insulation.
- D. Covering for "cold" pipes shall pass unbroken through hanger clevises, sleeves, etc. All details of covering for cold surfaces shall be such that continuous covering with unbroken vapor barrier and uncompressed insulation is provided as required to prevent condensation. The same covering and hanging detail shall be used for pipes connecting to vibrating equipment or carrying pulsating pressures to avoid metal contact between pipes and hangers.
- E. Insulation at removable heads, strainer plugs, and other access points shall be fabricated in such a manner that it can be readily removed without damage to the insulation. Removable insulation shall have a vapor proof cover fabricated so as to allow it to be resealed to the equipment vapor barrier.
- F. Provide rigid insulation inserts at hangers for pipes sizes 2" and larger. Inserts shall be polyisocyanurate or calcium silicate, a minimum of 180 degrees and extend 2" beyond the hanger shield. Refer to MICA Plate 1-610. Wood or plastic block hanger inserts shall not be used.
- G. Use hydraulic insulating cement anywhere insulation fibers are exposed, to fill voids, and to repair damages to the factory applied vapor barrier. Finish with material matching or compatible with adjacent jacket material.

*******NOTE: Not all services may apply – refer to plans for scope of services. *******

3.02 INSULATION SCHEDULE

Service	Type Insulation and Thickness*
Above Ground Piping	
Domestic cold water lines (including all pipe material types)	Type A and A1: All pipe sizes – 1" thick Type B and B1: 1-1/4" and smaller – 1/2" thick 1-1/2" and larger – 1" thick 1-1/4" and smaller – 1/2" thick 1-1/2" and larger – 1" thick
Domestic hot water, tempered water, and recirculating lines (including all pipe material types)	Type A and A1: 1 1/4" and smaller – 1" thick 1-1/2" and larger – 1-1/2" thick Type B and B1: 1 1/4" and smaller – 1" thick 1-1/2" and larger – 1-1/2" thick
Storm piping, sump pump discharge lines. Sanitary vent piping within ten feet of roof penetration	Type A and A1: 1" thick for all pipe sizes Type B and B1: 1" thick for all pipe sizes
Underside of roof drain bodies	Type G: 1" thick Type I: 3/4" thick
Underground / Underslab Piping	
Domestic hot water lines and recirculation lines (including all pipe material types)	Type B and B1: 1 1/4" and smaller – 1" thick 1-1/2" and larger – 1-1/2" thick
* Insulation type and thickness indicated in table apply for all pipe materials. **For piping exposed to outdoor ambient temperatures, increase thickness by 1/2"	

END OF SECTION 22 07 00

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**SECTION 22 11 16
DOMESTIC WATER PIPING**

PART 1 - GENERAL

1.01 RELATED WORK

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

1.02 DESCRIPTION OF WORK

- A. Contractor shall furnish all equipment, materials, tools, labor and supervision necessary to fabricate and install complete piping system as required by the drawings and this section.
 - 1. Extent of domestic water piping work is indicated on drawings and schedules, and by requirements of this section.
 - 2. Insulation of domestic water piping is specified in other Division 22 sections and is included as work of this section.
 - 3. Installation of valves for domestic water piping system is specified in other Division-22 sections and is included as work of this section.

1.03 QUALITY ASSURANCE

- A. ASME Compliance: Fabricate and install domestic water piping in accordance with ASME B31.9 "Building Services Piping".
- B. UPC Compliance: Fabricate and install domestic water piping in accordance with IAMPO "Uniform Plumbing Code".
- C. IPC Compliance: Fabricate and install domestic water piping in accordance with the "International Plumbing Code".
- D. Plumbing and Drainage Institute: Fabricate and install domestic water piping with Standard PDI-WH201.
- E. ANSI/NSF 372 Certification: All potable water supply piping, valves, fittings, and fixtures (excluding toilets, urinals, fill valves, flush valves, shower valves, and main gate valves greater than 2") shall meet the requirements for ANSI/NSF 372 Certification, Drinking Water System Components, Lead Content.

1.04 SUBMITTALS

- A. Submit manufacturer's material data and installation methods for each type of system to be provided.
- B. Submit manufacturer's catalog cuts for each type of device to be used.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Water Hammer Arrestors
 - 1. Ancon
 - 2. Sioux Chief
 - 3. Wade
 - 4. Watts
 - 5. Zurn
- B. Copper Pressure Seal Fittings
 - 1. Viega Pro Press
 - 2. NIBCO Press System

2.02 BASIC MATERIALS AND PRODUCTS

- A. General: Provide piping materials and factory fabricated piping products of sizes, types, pressure ratings, temperature ratings and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide materials and products complying with Uniform Plumbing Code and International Plumbing Code where applicable, base pressure rating on domestic water piping system's maximum design pressures. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in domestic water piping systems. Where more than one type of materials or products are indicated, selection is Installer's option.
- B. Valves: Refer to Section 22 05 23 - General Duty Valves for Plumbing Piping.
- C. Piping Specialties: Refer to Section - 22 05 00 - Common Work Results for Plumbing.
- D. Expansion Compensation: Refer to Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping.
- E. Meters and Gauges: Refer to Section 22 05 19 - Meters and Gages for Plumbing Piping.
- F. Supports, Anchors and Seals: Refer to Section 22 05 29 - Hangers and Supports for Plumbing Piping.

2.03 PIPE:

- A. Provide pipe materials meeting the following criteria and referenced standards:
 1. Ductile Iron Pipe (D-Iron): Cement lined ductile iron, ANSI/AWWA C104/A21.4.
 2. Type K Copper (K Cu): Type K copper water tube, hard temper, ASTM B88.
 3. Type L Copper (L Cu): Type L copper water tube, hard temper, ASTM B88.
 4. Brass (Brass): Schedule 40 Chromium plated, ASTM B43.
 5. Stainless Steel (St St): Type 304 schedule 10
- B. Unless specifically prohibited by local codes, provide piping materials for systems indicated according to the following table:

Service	Material						
	D-Iron	PVC	K Cu	L Cu	Brass	PEX	St St
Underground water service main for Fire Suppression (FX)	X						
Above ground water service main to Backflow Preventer (combined domestic/FX service)	X						
Domestic water below slab			X				
Water service pipes 2" and smaller		X	X				
Above ground domestic water				X			X
Exposed fixture connections					X		

2.04 FITTINGS:

- A. Cast iron water pipe: Class 250 ANSI A21.20, AWWA C110-71, standard mechanical joint fittings.
- B. Copper water tube cast bronze or wrought copper:
 1. Solder joint type. ANSI B16.18 and B16.22-63. Where copper piping is used for combined water/fire protection water service, joints upstream of fire protection backflow preventer shall be brazed.
 2. Pressure Seal pipe joining system, copper press fittings, 1/2" to 4" in diameter. ASME B16.18, ASME B16.22. O-rings for copper press fittings shall be EPDM. Installation per manufacturer's recommendations.
- C. Brass pipe: Cast bronze screwed, 125-pound, flat band water pattern, chromium plated, for chromium plated pipe.

2.05 JOINTS

- A. Copper water tube:
 - 1. Use non-corrosive 95-5 tin-antimony solder, cut pipe square, clean, ream and polish tube ends and inner surfaces of fittings, apply flux and solder joint as recommended by manufacturer of solder type fittings. Where copper piping is used for combined water/fire protection water service, joints upstream of fire protection backflow preventer shall be brazed.
 - 2. Pressure Seal pipe joining system, copper press fittings, 1/2" to 4" in diameter. ASME B16.18, ASME B16.22. O-rings for copper press fittings shall be EPDM.

2.06 NIPPLES AND UNIONS

- A. All nipples shall conform to size, weight and strength of adjoining pipe. When length of unthreaded portion of nipple is less than 1-1/2", use extra strong nipple; do not use close nipples.
- B. For pipe 2" and smaller, use screwed unions, for pipe 2-1/2" and over use flanged unions.
- C. Install unions in the following locations so that a minimum amount of pipe need be disassembled:
 - 1. Long runs, at intervals of 80 feet.
 - 2. In by-pass around equipment, valves, and controls.
 - 3. In connections to equipment.
 - 4. Where indicated on drawings.
- D. Dielectric unions shall be installed between any connection of copper pipe and ferrous piping or equipment. In grooved piping systems, provide Clearflo by Victaulic.

2.07 AIR VENTS

- A. Manual Air Vents: Bell & Gossett Model No. 17SR.
- B. Automatic Air Vents: Bell & Gossett Model No. 7

2.08 WATER HAMMER ARRESTORS

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

PART 3 - EXECUTION

3.01 INSPECTION

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

3.02 INSTALLATION OF BASIC MATERIALS AND PRODUCTS

- A. General: Install basic materials and products as per manufacturers' recommendations, Uniform and International Plumbing Codes, local code requirements and as required to meet system pressure and performance requirements.
- B. Piping Protection: Protect piping from damage during construction, including, but not limited to covering pipes during application of spray on fire-proofing to prevent fire proofing material from coming in contact with the pipes.
- C. Valves
 - 1. Refer to Section 22 05 23 - General Duty Valves for Plumbing Piping.
 - 2. Locate valves for easy access and operation. Do not locate valves with stems below horizontal.
 - 3. Sectional Valves: Install on each branch and riser, close to main, where branch or riser serves 2 or more plumbing fixtures and elsewhere as indicated.
 - 4. Shutoff Valves: Install on inlet and outlet of each domestic water equipment item and elsewhere as indicated.

- 5. Check Valves: Install on discharge side of each pump, and elsewhere as indicated.
- D. Piping Specialties: Refer to Section 22 05 00 - Common Work Results for Plumbing.
- E. Expansion Compensation Products: Refer to Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping.
- F. Meters and Gauges: Refer to Section 22 05 19 - Meters and Gages for Plumbing Piping.
- G. Supports and Anchors: Refer to Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment.

3.03 DOMESTIC WATER PIPING

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

3.04 EQUIPMENT CONNECTIONS

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

3.05 INSTALLATION OF FIXTURES

- A. Refer to Section 22 40 00 - Plumbing Fixtures, 22 45 00 - Emergency Plumbing Fixtures, and 22 47 00 - Drinking Fountains and Water Coolers.
- B. General: Connect water piping system to plumbing fixtures as indicated and comply with manufacturer's instructions where not otherwise indicated.
- C. Refer Water supply to all fixtures and containers shall be so installed as to prevent back siphonage of polluted water into the water supply. All supplies shall be either above the flood rim of the fixture or separated from the drainage end by means of approved vacuum breakers

3.06 INSTALLATION OF WATER HAMMER ARRESTORS

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

3.07 INSTALLATION OF PLUMBING SPECIALTIES

- A. General: Install plumbing specialties and valves as per manufacturer's installation instructions.
- B. Provide unions, valves to units at each connection as required by inspection.

3.08 HYDROSTATIC TESTING

- A. General: New water mains shall be subject to hydrostatic testing in accordance with AWWA C600 and other applicable AWWA Standards of latest revision and the following supplemental instructions.
- B. Supplemental Instructions:
 - 1. All newly laid pipe or any valved section thereof shall be subject to a hydrostatic pressure of 1.5 X the working pressure at the point of testing or 100 psig, whichever is greater.
 - 2. The test procedures shall:
 - a. Not exceed pipe or thrust restraint design pressures.
 - b. Be of at least 4-hour duration.
 - c. Not exceed the rated pressure of the valves or hydrants.
 - 3. Each valved section of pipe shall be filled with water slowly and the specified test pressure shall be applied by means of a pump connected to the pipe.
 - 4. Before applying the specified test pressure, air shall be expelled completely from the pipe, valves and hydrants.
 - 5. Any damaged or defective pipe, fittings, valves or hydrants that are discovered following the pressure test shall be repaired or replaced with sound material and the test shall be repeated.
 - 6. A leakage test shall be conducted concurrently with the pressure test. Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe, or any valved section thereof, to maintain test pressure.
 - 7. No pipe installation will be accepted where leakage is observed.

3.09 DISINFECTION

- A. General: Upon completion of a newly installed piping or when repairs to an existing pipe are made, the piping shall be disinfected according to instructions listed in AWWA C651, local codes, local utility requirements, and the following supplemental instructions.
- B. Repairs: Repairs to mains and plumbing shall be disinfected by swabbing with hypochlorite and flushing in accordance with AWWA C651.

END OF SECTION 22 11 16

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SECTION 22 13 16
SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.01 RELATED WORK

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

1.02 DESCRIPTION OF WORK

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

1.03 QUALITY ASSURANCE

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

1.04 SUBMITTALS

- A. Submit manufacturer's catalog cuts for each type of device to be used.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Floor Drains
 - 1. Jay R. Smith
 - 2. Jonespec
 - 3. Josam
 - 4. Wade
 - 5. Watts
 - 6. Zurn
- B. Trench Drains
 - 1. Jay R. Smith
 - 2. Watts
 - 3. Zurn
 - 4. Aco Drain
 - 5. ABT, Inc. (Polydrain)

2.02 BASIC MATERIALS AND PRODUCTS

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

2.03 PIPE:

- A. Provide pipe materials meeting the following criteria and referenced standards:
 1. Cast Iron Soil Pipe (C-Iron): Service class, bell and spigot, asphalt coated, ASTM A74.
 2. No-Hub Cast Iron Soil Pipe (C-Iron NH): Service class, no hub, asphalt coated, CISPI 301 or ASTM A-888.
 3. Polyvinyl Chloride (PVC): Schedule 40, DWV, ASTM D1785 and ASTM D2665.
 4. DWV Copper (DWV Cu): Drainage Waste and Vent copper pipe , ASTM B306.
 5. Brass (Brass): 17 gauge brass tube, chromium plated, ASTM B43.
 6. Acid Resistant Fire-Retardant Polypropylene (FR PP): Schedule 40 drainage pipe.
 7. Acid Resistant Polypropylene (PP): Schedule 40 drainage pipe.
 8. Chlorinated Polyvinyl Chloride (CPVC): Schedule 40, ASTM Cell Classification 23447, manufactured in accordance with ASTM F 2618.
- B. Unless specifically prohibited by local codes, provide piping materials for systems indicated according to the following table:

Service	Material							
	C-Iron	C-Iron NH	PVC	DWV Cu	Brass	FR PP	PP	CPVC
Sanitary waste and vent below slab to 5' outside building perimeter	X	X	X					
Sanitary waste and vent above slab, up to and including 2-1/2"		X	X	X				
Sanitary waste and vent above slab, 3" and larger	X	X	X	X				
Exposed fixture connections					X			
Urinal Branch Waste Pipes			X					

2.04 FITTINGS:

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

2.05 JOINTS

- A. Cast iron bell and spigot soil pipe: Pack joints with oakum, fill with molten lead at one pouring, caulk solid flush with hub rim. If approved by Code, pre-set plastic or neoprene joint may be used, ASTM C 564.
- B. Cast iron no-hub pipe: Coupling assembly tightened by torque wrench, CISPI 310, ASTM C 564.
- C. PVC pipe fittings (below grade sanitary sewer): Listed compression type joints.
- D. PVC DWV pipe: Solvent cement in accordance with ASTM D2564.

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

2.06 VENTS

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

Vent Size	Increase To
1-1/4" and 1-1/2"	3" minimum
2" and 2-1/2"	4" minimum
3"	4"
4"	6"

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

2.07 FLOOR DRAINS

- A. Shall be of the style as called for in fixture schedule.
- B. Drains without integral traps shall have service class p-traps.

2.08 CLEANOUTS

- A. In floors of finished areas: cast iron caulking ferrule for soil pipe hub with brass countersunk plug and cast brass round flush access cover with polished top.
- B. In floors of unfinished areas: cast iron with tapered body for caulking into soil pipe hub, with brass countersunk plug.
- C. In walls of finished areas: cast brass raised head plug and round stainless steel cover plate with polished top and countersunk cover screw. Provide with caulking ferrule where installed in cast iron soil pipe.
- D. In walls of unfinished areas: cast brass raised head, iron pipe size male threads. Provide with caulking ferrule where installed in iron soil pipe.
- E. In floors of areas subject to vehicular travel: cast iron with tapered body for caulking into soil pipe hub, with brass countersunk plug. Weight rated for fork truck and heavy traffic duty.

PART 3 - EXECUTION

3.01 INSPECTION

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

3.02 INSTALLATION OF BASIC MATERIALS AND PRODUCTS

- A. General: Install basic materials and products as required per manufacturer=s recommendations, International and Uniform Plumbing Codes, local code requirements and as required to meet the intent of the documents.
- B. No soil or waste pipe shall be covered by earth or construction without first being proved free of leaks by a hydrostatic test of at least 10 feet head.
- C. Install vents in practical alignment and supported with constant pitch back to the drainage system, concealed from finished spaces, unless shown or directed otherwise.
- D. Soil, waste and vent connections to fixtures shall be accurately located and concealed from finished spaces, unless indicated otherwise.

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

3.03 SANITARY WASTE AND VENT PIPING

- A. Install pipe for all sanitary waste and vent systems as indicated on drawings, as called for in other sections, and as specified herein.
- B. Arrange and install piping approximately as indicated; straight, plumb, and as direct as possible; form right angles on parallel lines with building walls. Keep pipes close to walls and avoid interference with other trades. Locate groups of pipes parallel to each other; space at a distance to permit applying full insulation and to permit access for servicing valves. Most piping to be run in concealed locations unless indicated exposed, or in equipment rooms. Locate piping to avoid ductwork.
- C. Provide proper support to maintain uniform fall of 1/4" per foot for lines 3" and smaller and 1/8" per foot for lines 4" and larger. Protect all openings against the entrance of dirt. Where piping must cross footings, the piping shall cross under footings unless noted otherwise on the drawings.
- D. Check all piping for interference with other trades, avoid placing water pipes over electrical equipment.
- E. Where rough-in is required for equipment furnished by others, verify exact rough-in dimension with owner or equipment supplier before roughing-in.
- F. Piping Specialties: Refer to Section 22 05 00 - Common Work Results for Plumbing.
- G. Supports, Anchors and Seals: Refer to Section 22 05 29 - Hangers and Supports for Plumbing Piping.
- H. Equipment Connections
 - 1. General: Connect sanitary waste and vent piping system to plumbing equipment as indicated, and comply with equipment manufacturer's instructions where not otherwise indicated. Install shutoff valve and union on supply and return, drain valve on drain connection.
- I. Field Quality Control
 - 1. Piping Tests: Test sanitary waste and vent piping in accordance with testing requirements of Division 22 Basic Materials and Methods, Section 22 00 10 - Plumbing General Provisions.
- J. Underground installation of thermoplastic pipe shall be done in accordance with ASTM D 2321.

3.04 INSTALLATION OF CLEANOUTS

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

3.05 INSTALLATION OF FLOOR DRAINS

- A. Obtain exact finished floor levels from the General Contractor and set floor drain top rims accurately to proper level below finished floor to allow for proper slope towards drains.

3.06 INSTALLATION OF FIXTURES

- A. Refer to Section 22 40 00 - Plumbing Fixtures, 22 45 00 - Emergency Plumbing Fixtures, and 22 47 00 - Drinking Fountains and Water Coolers.

END OF SECTION 22 13 16

**SECTION 22 40 00
PLUMBING FIXTURES**

PART 1 - GENERAL

1.01 RELATED WORK

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

1.02 DESCRIPTION OF WORK

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

1.03 SUBMITTALS

- A. Submit catalog cuts giving manufacturer's model numbers, fixture and rough in dimensions, and construction material for each type of fixture, trim and accessory scheduled.
- B. Furnish rough-in information that impacts other trades to General Contractor for distribution to other sub-contractors. This includes, but is not limited to, sink cut out templates, shower/tub framing dimension drawings, electrical power rough-in dimension drawings, etc.

1.04 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Refer to schedules on plans for basis of design plumbing fixtures. All other manufacturers must submit a substitution request for approval prior to bidding.
- B. Vitreous China and Cast Iron Enameled Fixtures
 - 1. American Standard
 - 2. Kohler
 - 3. Zurn
 - 4. Sloan
- C. Stainless Steel Sinks
 - 1. Elkay
 - 2. Just
 - 3. Kohler
 - 4. Franke
- D. Trim
 - 1. American Standard
 - 2. Chicago Faucet
 - 3. Delta
 - 4. Elkay
 - 5. Kohler
 - 6. T & S Brass Works
 - 7. Sloan
- E. Flush Valves
 - 1. Sloan - Royal Series
 - 2. Zurn – Aquavantage Series
- F. Carriers
 - 1. Jay R. Smith

2. Josam
 3. Wade
 4. Watts
 5. Zurn
- G. Valve Boxes
1. Guy Gray
- H. Fiberglass Tub and Shower Modules
1. Aquarius
 2. Oasis
 3. Aquatic
 4. Best Bath
- I. Closet Seats
1. Beneke
 2. Church
 3. Olsonite
 4. Sperzel
 5. Comfort Seats
 6. Bemis Commercial
 7. ProFlo
- J. Shower Valves
1. Leonard
 2. Symmons
 3. Delta
 4. Kohler
 5. Bradley
- K. Mop Sinks and Laundry Tubs
1. Fiat
 2. Mustee
 3. Pro Flo
- L. Thermostatic Mixing Valves
1. Leonard
 2. Powers
 3. Symmons
 4. Apollo
 5. Lawler
- M. Garbage Disposals
1. In-Sink-Erator
- N. Wall Hydrants
1. Woodford
 2. Prier
 3. JR Smith

2.02 VITREOUS AND CAST IRON FIXTURES

- A. Vitreous ware shall be non absorbant, even color, unwarped, two fired vitreous china, grade "A" as rated by the Bureau of Standards.
- B. Enameled cast iron fixtures shall have the enamel fused with the iron to provide a hard acid resisting enameled finish.
- C. Vitreous and enamel fixtures shall be white, except where other colors are called for in the schedule.
- D. Fiberglass, gel-coat fixtures shall incorporate Microban antimicrobial protection.

2.03 STAINLESS STEEL SINKS

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

2.04 ACCESSORIES

- A. Accessories to include supply pipes, stop valves, faucets, tail pieces, strainers, waste and traps. Floor and wall plates shall be brass. Exposed accessories shall be chrome plated.
- B. Potable water supply piping and fixtures and associated accessories (excluding toilets, urinals, fill valves, flush valves, and shower valves) shall meet the certification requirements of ANSI/NSF 372 – Drinking Water System Components, Lead Content.
- C. Stop valves shall be compression type with loose key control.
- D. P-trap shall be adjustable 18 gauge tubular brass. Where offset P-traps are required for handicapped accessible lavatories, offset and P-trap shall be insulated with Handi Lav-Guard by Truebro, or equal. When supply risers are exposed, they shall be insulated with Handi Lav-Guard by Truebro, or equal.
- E. Accessories shall be considered "exposed" even when concealed behind base cabinets having doors.
- F. Mixing valve, transformer, or piping under the counter shall be covered with Lav-Shield by Truebro or equal in areas where a cabinet does not cover them.
- G. Water closet fixture carriers shall be heavy duty type with a minimum weight rating of 500 lbs.

2.05 VALVE BOXES

- A. Box material shall be PVC High temperature Resin with Intumescent pad for to achieve fire rating required to match rating of wall where box is shown on plans. Snap on frame shall accommodate up to two layers of 5/8" drywall.
- B. Valves shall be included as indicated in Plumbing Fixture Schedule on the plans. All valves for domestic hot or cold water shall be lead free and comply with NSF/ANSI 372 (annex G) and the US Safe Drinking Water Act.
- C. Accessories: Provide other accessories as indicated in the Plumbing Fixture Schedule on the plans.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install fixtures and make water supply, waste and vent connections as indicated on the drawings.
- B. Set fixtures in center of stalls, between partitions where required. Dimensions for spacing shall be verified with General Contractor. Fixtures in ADA accessible stalls shall be installed with the flush valve handle to the open side of the stall, where applicable.
- C. Setting shall be absolutely tight and rigid on proper ground. Use Miracle Adhesive Corporation Tub Caulk or approved equal pointing material under all setting surfaces.
- D. Wall hung fixtures shall be securely hung. All wall hung fixtures shall have carriers unless other mounting means are approved by Design Professional. Mounting heights shall be as indicated on Architectural elevations, and in accordance with the requirements of the ADA.
- E. Chair carriers shall be securely braced to construction and shall be concealed with feet concealed in floor. Where feet cannot be concealed in floor, provide stub feet. Carriers for urinals shall have thrust bolts at bottom. Carriers for lavatories and electric water coolers shall have mounting plate type hanger or concealed arms as required by the fixture schedule. Carriers shall be coordinated with plumbing fixtures.
- F. Fixtures shall be covered after they are set to prevent damage during the balance of construction. At the conclusion of work, the covering shall be removed and the fixtures properly cleaned.

- G. Contractor shall be responsible for the protection of the fixtures until acceptance by Owner. Damaged fixtures shall be replaced at no additional cost to Owner.
- H. Joints of lavatories with counter and/or wall, sinks with wall, urinals with wall and water closets with wall and/or floor shall be caulked with transparent silicone caulk by Contractor.

END OF SECTION 22 40 00

SECTION 22 47 00
DRINKING FOUNTAINS AND WATER COOLERS

PART 1 - GENERAL

1.01 RELATED WORK

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

1.02 DESCRIPTION OF WORK

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

1.03 QUALITY ASSURANCE

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

1.04 SUBMITTALS

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

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

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

2.02 ELECTRIC WATER COOLERS

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

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install fixtures and make water supply, waste and vent connections as indicated on the drawings.
- B. Fixtures shall be covered after they are set to prevent damage during the balance of construction. At the conclusion of work, the covering shall be removed and the fixtures properly cleaned.
- C. Contractor shall be responsible for the protection of the fixtures until acceptance by Owner. Damaged fixtures shall be replaced at no additional cost to Owner.

END OF SECTION 22 47 00

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**SECTION 23 00 10
HVAC GENERAL PROVISIONS**

PART 1 - GENERAL

1.01 GENERAL

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

1.02 DESCRIPTION OF WORK

- A. This section applies to all work under the HVAC contract. This shall include, but not necessarily be limited to, the following:
 - 1. Piping Insulation
 - 2. Ductwork for Air Distribution
 - 3. Grilles, Registers, Diffusers and Dampers
 - 4. Exhaust Fans and Ducts
 - 5. Thermostats and Control Wiring
 - 6. Insulation of Ducts and Plenums
 - 7. Terminal Heating and Cooling Units
- B. The work shall include all materials, equipment and labor required for complete and properly functioning HVAC systems.
- C. Drawings for HVAC work are in part diagrammatic, intended to convey the scope of work and indicate general arrangement of equipment, piping and approximate sizes and locations of equipment and materials.
- D. Where job conditions require reasonable changes in indicated locations and arrangements, make such changes without additional cost to Owner.
- E. Because of the scale of the drawings, certain piping or items such as unions or fittings may not be shown, but where such items are required by other sections of the specifications, or where they are required by the nature of the work, they shall be furnished and installed.
- F. All elements of the construction shall be performed by workmen skilled in the particular craft involved, and regularly employed in that particular craft.
- G. All work shall be performed in a neat, workmanlike manner in keeping with the highest standards of the craft.

1.03 CODES AND STANDARDS

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

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

1.04 REQUIREMENTS & FEES OF REGULATORY AGENCIES

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

1.05 HVAC DRAWINGS

- A. The HVAC drawings indicate in general the building arrangement only, Contractor shall examine construction drawings to familiarize himself with the specific type of building construction, i.e. type of structural system, floors, walls, ceilings, room finishes and elevations.
- B. Drawings are intended to convey the scope of the work and to indicate the general arrangement and locations of ducts, piping and equipment.
- C. Contractor shall layout his own work and shall be responsible for determining the exact locations for equipment and rough-ins and the exact routing of piping and ducts so as to best fit the layout of the work.
- D. Contractor shall take his own field measurements for verifying locations and dimensions: scaling of the drawings will not be sufficient for laying out the work.
- E. Because of the scale of the drawings, certain basic items such as pipe fittings and valves may not be shown, but where such items are required by code or by other sections of the specifications, such items shall be furnished and installed.

1.06 ACTIVE SERVICES

- A. Contractor shall be responsible for verifying exact location of all existing services prior to beginning work in that area.
- B. Existing active services, i.e., water, gas, sewer, electric, when encountered, shall be protected against damage. Do not prevent or disturb operation of active services which are to remain.
- C. When active services are encountered which require relocation, Contractor shall make request to authorities with jurisdiction for determination of procedures.
- D. Where existing services are to be abandoned, they shall be terminated in conformance with requirements of the authorities having jurisdiction.

1.07 SITE INSPECTION

- A. Contractor shall inspect the site prior to submitting bid for work to familiarize himself with the conditions of the site which will affect his work and shall verify points of connection with utilities, routing of outside piping to include required clearances from any existing structures, trees or other obstacles.
- B. Extra payment will not be allowed for changes in the work required because of Contractor's failure to make this inspection.

1.08 COORDINATION AND COOPERATION

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

- C. Drawings and specifications are intended to be complimentary. Any work shown in either of them, whether in the other or not, shall be executed according to the true intent and meaning thereof, the same as if set forth in all. Conflicts between the drawings and the specifications or between the requirements set forth for the various contractors shall be called to the attention of Design Professional. If clarification is not asked for prior to the taking of bids, it will be assumed that none is required and that Contractor is in agreement with the drawings and specifications as issued. If clarification is required after the contract is awarded, such clarification will be made by Design Professional and his decision will be final.
- D. Special care shall be taken for protection for all equipment. All equipment and material shall be completely protected from weather elements, painting and plaster until the project is substantially completed. Damage from rust, paint and scratches shall be repaired as required to restore equipment to original condition.
- E. Protection of all equipment during the painting of the building shall be the responsibility of the Painting Contractor, but this shall not relieve Contractor of the responsibility for checking to assure that adequate protection is being provided.
- F. Where the final installation or connection of equipment in the building requires Contractor to work in finished areas of the building, Contractor shall be responsible that such areas are protected and are not marred, soiled or otherwise damaged during the course of such work. Contractor shall arrange with the General Contractor for patching and refinishing of such areas which may be damaged in this respect.

1.09 OPENINGS, CUTTING AND PATCHING

- A. Piping, sleeves and ducts passing through all fire or smoke rated floors, roofs, walls, and partitions shall be provided with firestopping. Space between wall/floor and pipe, sleeve, and/or duct shall be sealed with UL listed intumescent material equivalent to rating of wall/floor. Where piping, sleeves and ducts pass through floors, roofs, walls and partitions that are not fire or smoke rated, penetrations shall be sealed with grout or caulk.
- B. New structure:
 - 1. Contractor will coordinate the placing of openings and lintels in the new structure as required for the installation of the HVAC work with the General Contractor.
 - 2. Contractor shall furnish to General Contractor the accurate locations and sizes for required openings, but this shall not relieve Contractor of the responsibility of checking to assure that proper size openings are provided. When additional cutting and patching is required due to Contractor's failure to coordinate this work, Contractor shall make arrangements for the cutting, patching, and painting required.
- C. Existing Structure:
 - 1. Contractor shall provide cutting, lintels and patching, and patch painting in the existing structure, as required for the installation of his work, and shall furnish lintels and supports as required for openings.
 - 2. Cutting of structural support members will not be permitted without prior approval of the Design Professional. Extent of cutting shall be minimized; use core drills, power saws or other machines which will provide neat, minimum openings.
 - 3. Patching shall match adjacent materials and surfaces and shall be performed by craftsmen skilled in the respective craft required.

1.10 MATERIALS AND EQUIPMENT

- A. All materials and equipment shall be the standard product of a reputable U.S.A. manufacturer regularly engaged in the manufacture of the specified item. Where two or more units are required of the same item, they shall be furnished by the same manufacturer except where specified otherwise.
- B. All material and equipment shall be installed in strict accordance with the manufacturer's recommendations.

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

1.11 SUBMITTALS

- A. Contractor shall furnish, to Design Professional, complete sets of shop drawings and other submittal data. Contractor shall review and sign shop drawings before submittal. Refer to Division 01 specifications for additional requirements. Refer to Section 01 30 00 - Administrative Requirements for additional requirements.
- B. Shop drawings shall be bound into sets and cover related items for a complete system as much as practical and shall be identified with symbols or "plan marks" used on drawings. Incomplete, piecemeal or unbound submittals will be rejected.
- C. Submittals required by the various sections of the Project Manual include, but are not necessarily limited to those identified in the submittal schedule below.
- D. After award of contract, Contractor shall provide a completed submittal schedule including dates that the submittals will be to Design Professional for review.
- E. Submit required information on the following items:

SPEC SECTION	EQUIPMENT	DETAIL DWGS	PROD DATA	SAMPLES	INSTALL METHODS	O & M MANUAL	CERTIFICATE OF DEMONSTRATION	OTHER (SEE NOTES)
23 05 53	HVAC Identification		X					
23 05 93	Testing, Adjusting and Balancing for HVAC							1
23 07 00	HVAC Insulation		X					
23 09 00	Building Automation System	X	X			X	X	
23 31 13	Metal Ducts	X	X					1
23 33 00	Air Duct Accessories		X			X		
23 34 16	HVAC Fans		X			X	X	
23 36 00	Air Terminal Units		X			X		
23 37 13	Diffusers, Registers and Grilles		X					
23 38 13	Commercial Kitchen Exhaust Equipment		X			X		
23 82 19	Fan Coil Units		X			X		
23 82 39	Unit Heaters		X			X		
NOTES:								
1. Submit test reports as described in specification section.								

- F. Design Professional will review shop drawings solely to assist contractors in correctly interpreting the plans and specifications.
- G. Contract requirements cannot be changed by shop drawings which differ from contract drawings and specifications.

1.12 OPERATION AND MAINTENANCE MANUALS

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

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

OPERATION
AND
MAINTENANCE
MANUAL
FOR
HVAC SYSTEMS

(PROJECT NAME)
(LOCATION)
(DATE)

SUBMITTED BY
(NAME AND ADDRESS OF CONTRACTOR)

- C. Provide a master index at the beginning of manual showing items included. Use plastic tab indexes for sections of manual. Each section shall contain the following information for equipment furnished under this contract:
1. Equipment and system warranties and guarantees.
 2. Installation instructions.
 3. Operating instructions.
 4. Maintenance instructions.
 5. Spare parts identification and ordering list.
 6. Local service organization, address, contract and phone number.
 7. Shop drawings with reviewed stamp of Design Professional and Contractor shall be included, if applicable, along with the items listed above.
 8. Reports of all tests and demonstrations including certificate of owner instruction, testing and balancing report, etc.

1.13 TESTS AND DEMONSTRATIONS

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

<u>System</u>	<u>Pressure</u>
Refrigeration Piping: Precharged Lines	Charge and operate unit. Check for leaks with electronic leak detector.

- B. All systems shall be tested by Contractor and placed in proper working order prior to demonstrating systems to Owner. Contractor shall submit a report to Design Professional citing dates, times, pressures, and results of all tests performed.

1.14 TRAINING AND DEMONSTRATIONS

- A. Prior to acceptance of the HVAC installation, Contractor shall provide to Owner, or his designated representatives, all comprehensive training on essential features and functions of all systems installed, and shall instruct Owner in the proper operation and maintenance of such systems.
1. Provide adequate notice to Owner as to when instruction will be conducted so appropriate personnel can be present.
 2. Prepare the instruction format for a minimum of four Owner Representatives.
- B. Equipment training for Owner:
1. Manufacturer's representatives shall provide instruction on each major piece of equipment. Contractor shall provide instruction on all other equipment.

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

C. System training for Owner:

1. HVAC and Temperature Controls Contractors shall jointly conduct system operating training. These sessions shall include:
 - a. HVAC system overview.
 - b. System wide start-up.
 - c. Operation of control system.
 - d. Function of each component.
 - e. System operating procedures in all possible modes.
 - f. Programming procedures.
 - g. Shut-down and maintenance procedures.
 - h. Emergency procedures.

D. The following are minimum requirements for Owner instruction:

Section	Description	Hours (Note 1)	Presented By	Others Present	Remarks
23 00 10	HVAC System (Excluding Equipment)	8	Mech. Contractor T.C. Contractor		Note 2
23 34 16	Fans	2	Contractor		
23 09 00	Temperature Control System	40	T.C. Contractor		Note 3

1. Any unused hours shall be used at Owner's discretion during the first year of occupancy.
2. System training shall include, but not be limited to, valve locations, system routing, and air/water flow patterns, system start-up/shut-down/emergency procedures.
3. Training shall occur in several sessions over the course of the first year of operation. A minimum of four separate dates are required for temperature controls, two dates for chillers.

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

CERTIFICATE OF SYSTEM DEMONSTRATION

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

- A. Project:
- B. System(s):
- C. Contractor's representatives giving instruction and demonstration:

Contractor: _____

NAMES	DATE	HOURS

- D. Owner's representatives receiving instruction:

Owner: _____

NAMES	DATE	HOURS

- E. Acknowledgement of demonstration:

Contractor's Representative:

_____ signature

_____ date

Owner's Representative:

_____ signature

_____ date

1.15 SUBSTITUTIONS

- A. Refer to Divisions 00 and 01. Refer to Section 01 25 00 – Substitution Procedures.
- B. Where substitutions are approved, Contractor assumes all responsibility for physical dimensions and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of the substitution.

1.16 ACCEPTABLE MANUFACTURERS

- A. In most cases, equipment specifications are based on a specific manufacturer's type, style, dimensional data, catalog number, etc. Listed with the base specification, either in the manual or on the plan schedules are acceptable manufacturers approved to bid products of equal quality. These manufacturers are encouraged to submit to Design Professional at least 8 days prior to the bid due date drawings and catalog numbers of products to be bid as equals.
- B. Manufacturers who do not submit prior to bidding, run the risk of having the product rejected at time of shop drawing submittal. Extra costs associated with replacing the rejected product shall be the responsibility of Contractor and/or the manufacturer.
- C. If Contractor chooses to use a manufacturer listed as an equal, it shall be his responsibility to assure that the manufacturer has complied with the requirements in 'A' above. Contractor shall assume all responsibility for physical dimensions (including accessibility for maintenance), operating characteristics, and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of using the alternate manufacturer.
- D. Where a model or catalog number is provided, it may not be inclusive of all product requirements. Refer to additional requirements provided on the plans or in the specifications as required. Similarly, there may be additional requirements included in the model or catalog number that are not specifically stated. These requirements shall also be met.

1.17 WARRANTY

- A. Refer to Divisions 00 and 01 for information on warranties and correction of work within the warranty period.
 - 1. If a warranty or warranty period are not defined in Division 00 or 01, then the start of all warranty periods shall be the date of Substantial Completion and the length of the warranty shall be for one year.
 - a. If construction is phased with distinct and separate Substantial Completion dates for portions of the building and/or systems, separate warranties shall be provided for each of these phased areas and/or systems.
 - b. The entire HVAC system, including all sub-systems, shall be guaranteed against defect in materials and installation for the duration of the warranty period. Any malfunctions or defects which occur within the warranty period shall be promptly corrected without cost to the Owner. This guarantee shall not limit or void any manufacturer's express or implied warranty.
- B. Refer to other Division 23 sections for systems, equipment, or material requiring extended warranties.
- C. The date of systems/equipment startup or equipment/material shipment to the site shall not be considered the notable date with relation to the warranty of that item. All systems, equipment, material, etc., shall have the same start date with respect to the warranty period.
- D. Systems, equipment or material put into use to facilitate construction activities (e.g. testing and balancing, commissioning, temporary conditioning, etc.) prior to the start of the warranty period shall not impact the length of the warranty in any way.

1.18 COMPLETION

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

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

1.19 CLEANING

- A. Prior to assembly of pipe and piping components, all loose dirt, scale, oil, and other foreign matter on internal and exterior surfaces shall be removed by means consistent with good piping practices. During fabrication and assembly, slug and weld splatter shall be removed from both internal and external pipe joints by preening, chipping, and wire brushing.
- B. At the conclusion of the construction, the entire system of piping and equipment shall be cleaned internally. Prior to flushing erected piping surfaces, Contractor shall disconnect all instrumentation and equipment and open wide all valves.
- C. All temporary labels, stickers, etc., shall be removed from all fixtures and equipment. Name plates, ratings, instruction plates, etc., shall not be obscured by paint, insulation, or placement of units.
- D. Heating and air conditioning equipment shall be thoroughly cleaned and clean filters installed.

1.20 ELECTRICAL WORK

- A. Electrical work and equipment provided by HVAC Contractor shall include the following:
 - 1. Starters and disconnects for motors of HVAC equipment, but only where specifically indicated to be furnished integrally with equipment.
 - 2. Wiring from motors to disconnect switches or junction boxes for motors of HVAC equipment, but only where specifically indicated to be furnished integrally with equipment.
 - 3. Electrical heating coils and similar elements in HVAC equipment.
 - 4. All control wiring in accordance with the requirements of Division 26.
- B. Electrical Contractor shall provide all power wiring for HVAC equipment, including services for motors and equipment furnished by the HVAC contractor. Motor and equipment locations are shown on the electrical drawings.
- C. Electrical Contractor shall make final connections for all motors and equipment furnished by the HVAC contractor.
- D. Electrical Contractor shall furnish safety disconnects and starters for all motors and equipment furnished by the HVAC contractor (unless specifically indicated to be furnished integrally with the equipment), so as to make service complete to each item of equipment.
- E. Contractor shall consult with Electrical Contractor prior to conduit rough-in and shall verify with him the exact locations for rough-ins, and the exact size and characteristics of the services required, and shall provide Electrical Contractor a schedule of electrical loads for the equipment furnished by him. These schedules will be used for sizing services, disconnects, fuses, starters and overload protection.
- F. Refer to Division 23 Controls section for control system wiring. Control wiring shall be done in accordance with the requirements of Division 26.
- G. All control wiring shall be in blue conduit.

1.21 TEMPORARY UTILITIES

- A. Refer to Division 01 for specific requirements concerning temporary utilities.
- B. Under no circumstances shall the building HVAC equipment be used for temporary heat, cooling or ventilation during construction prior to Owner acceptance of the building at substantial completion.

END OF SECTION 23 00 10

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**SECTION 23 05 00
COMMON WORK RESULTS FOR HVAC**

PART 1 - GENERAL

1.01 GENERAL

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

- A. This section includes the following:
 - 1. Demolition
 - 2. Sleeves
 - 3. Escutcheons
 - 4. Fire Stopping
 - 5. Guards

PART 2 - PRODUCTS

2.01 DEMOLITION MATERIALS

- A. All materials removed shall be the property of the removing contractor and shall be removed from the site by him, unless otherwise specified.

2.02 SLEEVES

- A. Sleeves passing through non load bearing walls and partitions shall be galvanized sheet steel with lock seam joints of minimum gauges as follows:
 - 1. For pipes 2 1/2" and smaller 24 gauge
 - 2. For pipes 3" to 6" 22 gauge
 - 3. For pipes over 6" 20 gauge
- B. Sleeves passing through load bearing walls, concrete beams, fireproof walls, foundations, footings and waterproof floors shall be Schedule 40 steel pipe or cast iron pipe.
- C. Sleeves are not required in masonry walls which are core drilled or walls of drywall construction, except where partition is a firestop, smokestop, or side of air plenum.
- D. Sleeves for insulated piping shall be of sufficient internal diameter to take pipe and insulation and to allow for free movement of pipe. Waterproof sleeves shall be of sufficient internal diameter to take pipe and waterproofing material.
- E. In finished areas where pipes are exposed, sleeves shall be terminated flush with wall, partitions and ceilings, and shall extend 1/2" above finished floors. Extend sleeves 1" above finished floors in areas likely to entrap water and fill space between sleeves and pipe with graphite packing and caulking compound.
- F. Sleeves passing through membrane waterproofing or lead safe shall be provided with flashing, furnished and installed by General Contractor, extending 12" beyond sleeve in all directions; flashing shall be secured and sealed to membrane or lead safe and shall be sealed to sleeve and caulked watertight. Sleeves passing through roof shall be installed in same manner except sleeves shall extend to 6" above roof.
- G. For exterior walls below grade, sleeves shall be cast iron. Space between sleeve and pipe shall be sealed with modular rubber links tightened with bolts (Link-Seal or equal). Waterproofing of pipe penetrations in exterior walls shall be coordinated with waterproofing contractor.

2.03 ESCUTCHEONS

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

2.04 FIRESTOPPING

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

PART 3 - EXECUTION

3.01 DEMOLITION

- A. General:
 - 1. Demolition shall be accomplished by the proper tools and equipment for the work to be removed. Personnel shall be experienced and qualified in the type of work to be performed.
 - 2. Contractor shall remove existing equipment and piping not necessary for additions or existing portions of building as indicated on drawings and/or specified herein. To include all abandoned equipment and piping back to point of origin. Demolition of equipment shall include removal associated concrete equipment pad and/or support steel.
 - 3. Contractor shall be responsible for the cutting and capping of all existing services before any work is commenced by the General Contractor.
- B. Work by Others: Unless specifically noted under other contracts, Contractor shall assume all required work shall be performed by him. In general, the following will be performed by others:
 - 1. General Contractor will remove any floors, walls and ceilings, neatly patch, match, complete and finish all affected surfaces.
 - 2. Electrical Contractor will disconnect all electrical services and remove abandoned conduit back to point of origin.
- C. Existing Conditions:
 - 1. If any piping serving existing fixtures or equipment which are to remain are disturbed by operations under this Contract, Contractor shall provide pipe and insulation required to reestablish continuity of such piping systems.
 - 2. Contractor shall arrange for General Contractor to repair, patch and paint all construction, with material necessary to match surrounding material, which is necessary due to removal of equipment and piping.
 - 3. Contractor shall furnish all required labor and material where required to extend new work to connect to similar work where new addition adjoins existing building and for extension of existing system. Connection shall be made in a suitable manner.
- D. Owner's Right of Salvage: The Owner may designate and have salvage rights to any material herein demolished by the Contractor.

3.02 SLEEVES

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

3.03 ESCUTCHEONS

- A. Install escutcheons for all pipes entering finished spaces.

3.04 GUARDS

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

3.05 ACCESS DOORS

- A. Install access doors per manufacturer's recommendations.

END OF SECTION 23 05 00

**SECTION 23 05 13
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT**

PART 1 - GENERAL

1.01 GENERAL

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

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

1.03 SUBMITTALS

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

PART 2 - PRODUCTS

2.01 GENERAL

- A. Comply with NEMA MG1 unless noted otherwise.
- B. Constant Speed Motors: Minimum 1.15 service factor; rated at 40 deg. C. ambient temperature with 90 deg. C. temperature rise (Class B insulation).
- C. Motors Used with Variable Frequency Controllers: Inverter duty rated, Class F insulation (minimum). Windings shall be copper magnet with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters. Shall include Aegis motor shaft grounding rings.
- D. Multiple speed motors: Multiple windings.
- E. Motor Efficiency: Premium efficiency as defined in NEMA MG1.
- F. All motors shall be provided as required for motor orientation within equipment.
- G. Horsepower ratings shall be adequate for operating the connected loads continuously in the prevailing ambient temperatures in areas where the motors are installed, without exceeding the NEMA standard temperature rises for the motor insulations.
- H. Motor designs, as indicated by the NEMA code letters, shall be coordinated with the connected loads to assure adequate starting and running torques.
- I. Motor Enclosures:
 - 1. Shall be the NEMA types shown on the drawings for the motors.
 - 2. Where the types of motor enclosures are not shown on the drawings, they shall be the NEMA types which are most suitable for the environmental conditions where the motors are being installed. Motors located outdoors to be totally enclosed weatherproof epoxy-sealed type.
 - 3. Thoroughly clean and paint the enclosures at the factory with manufacturer's prime coat and standard finish.
- J. Additional requirements for specific motors, as indicated in other sections, shall also apply.

2.02 SINGLE PHASE POWER

- A. Capacitor start motors starting torque shall be three times full load torque and starting current shall be less than five times full load current.
- B. Pull-up Torque: Up to 350 percent of full load torque.
- C. Breakdown Torque: Approximately 250 percent of full load torque.
- D. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
- E. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.
- F. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.03 THREE PHASE POWER - SQUIRREL CAGE MOTORS

- A. Starting Torque: Between 1 and 1-1/2 times full load torque.
- B. Starting Current: Six times full load current.
- C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.
- D. Design, Construction, Testing and Performance: Conform to NEMA MG 1 for Design B motors.
- E. Insulation System: NEMA Class B or better.
- F. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.
- G. Motor Frames: NEMA Standard T-Frames of steel, aluminum or cast iron with end brackets of cast iron or aluminum with steel inserts.
- H. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter.
- I. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum AFBMA 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

2.04 ELECTRONICALLY COMMUTATED MOTORS

- A. Where indicated, provide electronically commutated motors with the following features:
 - 1. Brushless, permanent magnet DC motor
 - 2. Built in inverter
 - 3. Microprocessor based controller for speed control.
 - 4. 0-10VDC or 0-20mA input signal
 - 5. Minimum 70% efficiency through all speeds.
 - 6. Bearings rated for L10 40,000 hours of continuous operation

PART 3 - EXECUTION (Not Used)

END OF SECTION 23 05 13

SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING, DUCTWORK AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

- A. Extent of identification work required by this section is indicated on drawings and/or specified in other Division 23 sections.
- B. Type of identification devices specified in this section include the following:
 - 1. Painted identification materials
 - 2. Plastic pipe and duct markers
 - 3. Plastic tape
 - 4. Valve tags
- C. Identification furnished as part of factory fabricated equipment, is specified as part of the equipment assembly in other Division 23 sections.

1.03 QUALITY ASSURANCE

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

1.04 SUBMITTALS

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

PART 2 - PRODUCTS

2.01 IDENTIFICATION MATERIALS

- A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 23 sections. Where more than one single type is specified for an application, selection is Installer's option, but provide single selection for each product category.
- B. Painted Identification Materials:
 - 1. Stencils: Standard fiberboard stencils, prepared for required applications with letter sizes generally complying with recommendations of ANSI A13.1 for piping and similar applications, but not less than 3/4" high letters for access door signs and similar operational instructions.
 - 2. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray can form and grade.
 - 3. Identification Paint: Standard identification enamel of colors indicated, or, if not otherwise indicated for piping systems, comply with color chart below for colors.
- C. Plastic Pipe and Duct Markers:
 - 1. General: Provide manufacturer's standard preprinted flexible or semi rigid, permanent, color coded, plastic sheet pipe and duct markers.
 - 2. Color: Color of pipe and duct markers shall comply with ANSI A13.1.

3. Small Pipes: For external diameters not greater than 6" (including insulation if any), provide full band pipe markers extending 360 degrees around pipe at each location, fastened by one of the following methods:
 - a. Snap on application of pre tensioned semi rigid plastic pipe marker.
 - b. Adhesive lap joint in pipe marker overlap.
 - c. Laminated or bonded application of pipe marker to pipe (or insulation).
 - d. Taped to pipe (or insulation) with color coded plastic adhesive tape, not less than 3/4" wide full circle at both ends of pipe marker, tape lapped 1 1/2".
 4. Large Pipes: For external diameters of 6" and larger (including insulation if any), provide either full band or narrow strip type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:
 - a. Laminated or bonded application of pipe marker to pipe (or insulation).
 - b. Taped to pipe (or insulation) with color coded plastic adhesive tape, not less than 1 1/2" wide; full circle at both ends of pipe marker, tape lapped 3".
 - c. Strapped to pipe (or insulation) application of semi rigid type, with manufacturer's standard stainless-steel bands.
 5. Ducts: Provide either full band or narrow strip type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:
 - a. Laminated or bonded application of marker to duct (or insulation).
 - b. Taped to duct (or insulation) with color coded plastic adhesive tape, not less than 1 1/2" wide; full circle at both ends of marker, tape lapped 3".
 6. Lettering: Manufacturer's standard preprinted nomenclature which best describes piping system in each instance, as selected by Design Professional in cases of variance with names as shown or specified.
 7. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as a separate unit of plastic.
- D. Plastic Tape:
1. General: Manufacturer's standard color-coded pressure sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.
 - a. Width: Provide 1 1/2" wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6", 2 1/2" wide tape for larger pipes or ducts.
 - b. Color: Same as indicated for Plastic Pipe or Duct Markers.
- E. Valve Tags:
1. Brass Valve Tags: Provide polished brass valve tags with stamp engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 7/16" high, and with 3/16" hole for fastener. Tag thickness 0.040 inches.
 - a. Provide 2" diameter tags, except as otherwise indicated.
 - b. Fill tag engraving with black enamel.
 2. Plastic Valve Tags: Provide red heavy plastic tag with 7/16" white embossed sequenced numbers.
 3. Valve Tag Fasteners: Manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S hooks or heat-sealed braided copper wire of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
- F. Name Plates:
1. General: Provide manufacturer's standard preprinted plastic, brass, or aluminum with stamped, engraved or embossed letters.
 2. Lettering:
 - a. Large Equipment: 1 1/2" lettering as appropriate.
 - b. Small Equipment: 3/4" lettering as appropriate.
 3. Attachments: Mounting holes and screws, pressure sensitive adhesive backing, or solid brass chain.

2.02 LETTERING AND GRAPHICS

- A. General: Coordinate names, abbreviations and other designations used in HVAC identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of HVAC systems and equipment.
 - 1. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Boiler No. 3, Air Supply No. 1H, Standpipe F12).

PART 3 - EXECUTION

3.01 APPLICATION AND INSTALLATION

- A. General Installation Requirements:
 - 1. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish including valve tags, install identification after completion of covering and painting if any. Install identification prior to installation of acoustical ceilings and similar concealment.
- B. Ductwork Identification:
 - 1. Access Doors: Provide stenciled or plastic laminate type signs on each access door in ductwork and housings, indicating purpose of access (to what equipment) and other maintenance and operating instructions, and appropriate safety and procedural information.
 - 2. Locate duct markers and color bands as follows wherever ductwork is exposed to view in unoccupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non concealed locations. Install markers such that lettering is visible from floor.
 - a. Near each control device.
 - b. Near each branch, excluding short take offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
 - c. Near locations where ducts pass through walls or floors/ceilings, or enter non accessible enclosures.
 - d. Near major equipment items and other points of origination and termination.
 - e. Spaced intermediately at maximum spacing of 20' along each duct run with a minimum of one marker in each room.
 - f. On ducts above removable acoustical ceilings.
- C. Piping System Identification:
 - 1. General: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:
 - a. Stenciled markers, including color coded background band or rectangle, and contrasting lettering of black or white. Extend color band or rectangle 2" beyond ends of lettering.
 - b. Plastic pipe markers, with application system as indicated under "Materials" in this section.
 - c. Stenciled markers, black or white for best contrast, wherever continuous color coded painting of piping is provided.
 - 2. Locate pipe markers and color bands as follows wherever piping is exposed to view in unoccupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non concealed locations. Install markers such that lettering is visible from floor.
 - a. Near each valve and control device.
 - b. Near each branch, excluding short take offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
 - c. Near locations where pipes pass through walls or floors/ceilings, or enter non accessible enclosures.

- d. At access doors, manholes and similar access points which permit view of concealed piping.
 - e. Near major equipment items and other points of origination and termination.
 - f. Spaced intermediately at maximum spacing of 20' along each piping run with a minimum of one marker in each room.
 - g. On piping above removable acoustical ceilings.
- D. Valve Identification:
- 1. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory fabricated equipment units, and shut off valves at terminal devices and similar rough in connections of end use fixtures and units. List each tagged valve in valve schedule for each piping system.
- E. Equipment Identification:
- 1. General: Provide equipment identification for all equipment.
 - 2. Labeling: All equipment shall be labeled as per construction document plan marks or as designated by Owner.
 - 3. Provide identification by means of nameplates or stenciled painting as appropriate.
 - a. For equipment with factory furnished casing, identification shall be by adhesive fixed name plates.
 - b. Field insulated items, such as heat exchangers may be identified by plastic pipe markers or stenciled lettering.

END OF SECTION 23 05 53

SECTION 23 05 93
TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

- A. Extent of testing, adjusting and balancing work is indicated by requirements of this section, and also by drawings and schedules, and is defined to include, but is not necessarily limited to, air and hydronic distribution systems, domestic water circulation and associated equipment and apparatus of mechanical work. The work consists of setting speed and volume (including pulley changes as required), adjustments of system components, recording data, conducting tests, preparing and submitting reports, and recommending modifications to work as required by contract documents. Entering, navigating the Building Automation System in order to adjusting 'K factors' and related items is also required.
- B. Component types of testing, adjusting and balancing specified in this section includes the following as applied to HVAC equipment:
 - 1. Air Systems:
 - a. Air Handling Units
 - b. Fan Coil Units
 - c. Exhaust Fans
 - d. Ductwork Systems
 - e. Diffusers and Grilles
 - 2. Water Systems:
 - a. Domestic Hot Water Recirculating System
- C. The Heating and Air Conditioning Contractor shall provide a complete and operating HVAC system and shall cooperate with the balancing agency by:
 - 1. Installing balancing dampers as required by the Drawings and Specifications and requested by the Testing and Balancing Contractor.
 - 2. Putting complete system into operation during duration of balancing period.
 - 3. Providing up-to-date set of Drawings and advising immediately of any changes made to the system during construction.
 - 4. Providing labor and equipment and cost of performing corrections, such as dampers, belts, etc., as required without undue delay.
 - 5. Providing complete submittal information for all HVAC equipment, complete with pertinent engineering information.

1.03 REFERENCES

- A. Associated Air Balance Council (AABC) - National Standards for Field Measurement and Instrumentation, Total System Balance.
- B. ASHRAE - HVAC Applications Handbook: Chapter 34, Testing, Adjusting and Balancing. (Most recent edition).
- C. National Environmental Balancing Bureau (NEBB) - Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

1.04 QUALITY ASSURANCE

- A. Tester: A firm with at least 3 years of successful testing, adjusting and balancing experience on projects with testing and balancing requirements similar to those required for this project, who is not Installer of system to be tested and is otherwise independent of project.

- B. TAB Agency Qualification: Current membership in AABC or certification by NEBB.
- C. Test Equipment Criteria: The basic instrumentation requirements and accuracy/calibration required by AABC, National Standards or by NEBB Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems.
- D. All testing and balancing contractors are to be approved by the Design Professional before bidding. The contractors approved to date are:
 - 1. Precision Test and Balance
Clive, Iowa
(515) 288-2332
 - 2. Systems Management and Balancing
Waukee, Iowa
(515) 987-2825
 - 3. Omega Test and Balance
Adel, Iowa
(515) 729-6046

1.05 JOB CONDITIONS

- A. Do not proceed with testing, adjusting and balancing work until work has been completed and is operable. Ensure that there is no latent residual work still to be completed.
- B. Do not proceed until work scheduled for testing, adjusting and balancing is clean and free from debris, dirt and discarded building materials.

1.06 SUBMITTALS

- A. The test-and-balance report shall be complete with logs, data, and records as required herein. All logs, data, and records shall be typed on white bond paper and bound. The report shall be certified accurate and complete by the balancing agency's certified test-and-balance engineer.
- B. Submit electronic pdf file of the test-and-balance report to Design Professional.
- C. The report shall contain the required data in a format selected by Balancing Contractor.
- D. Report shall include the following information: (For all references to "design", specific information from shop drawings shall be incorporated.)
 - 1. Air Moving Equipment:
 - a. Location
 - b. Manufacturer and Model
 - c. Supply, return and exhaust, air flow, design and actual
 - d. Outside air flow, design and actual (where applicable)
 - e. Inlet, discharge, and total static pressure, design and actual
 - f. Full static pressure profile with measurements between all components through unit.
 - g. Fan RPM, design and actual
 - h. Static pressure across the coil section with the face and bypass damper in both the face and bypass positions (where face and bypass dampers are provided).
 - 2. V-Belt Drive:
 - a. Identification/location
 - b. Required driven RPM
 - c. Driven sheave, diameter and RPM
 - d. Belt, size and quantity
 - e. Motor sheave, diameter and RPM
 - 3. Duct Traverse:
 - a. System zone/branch
 - b. Duct size and area
 - c. Velocity and airflow, design and actual
 - d. Duct static pressure
 - e. Air temperature and correction factor (if applicable)

4. Air Monitoring Station Data:
 - a. Identification/location
 - b. System
 - c. Size and area
 - d. Velocity and airflow, design and actual
5. Air Terminal Unit Data:
 - a. Identification/number and location
 - b. Manufacturer and model
 - c. Size
 - d. Minimum static pressure, design and actual
 - e. Maximum air flows, design and actual
 - f. Minimum air flow, design and actual
6. Room Air Distribution Test Sheet:
 - a. Air terminal number
 - b. Room number/location
 - c. Terminal type and size
 - d. Area factor
 - e. Velocity, design and actual
 - f. Air flow, design and actual
 - g. Percent of design air flow
7. Air outlet differential pressure (for underfloor plenums) Terminal Unit Heating and Cooling Coil Data
 - a. Identification/number
 - b. Manufacturer and model
 - c. Entering and leaving DB temperature, design and actual
 - d. Entering and leaving water temperature, design and actual
 - e. Water flow, design and actual
 - f. Differential pressure across balancing valves.
8. Electric Motors:
 - a. Manufacturer (1/4 hp and larger only)
 - b. HP/BHP, design and actual
 - c. Phase, voltage, amperage; design and actual
 - d. Service factor
 - e. Starter size, rating, heater elements (as applicable)

PART 2 - PRODUCTS

2.01 PATCHING MATERIALS

- A. Except as otherwise indicated, use same products as used by original Installer for patching holes in insulation, ductwork and housings which have been cut or drilled for test purposes, including access for test instruments, attaching jibs, and similar purposes.
 1. At Tester's option, plastic plugs with retainers may be used to patch drilled holes in ductwork and housings.

PART 3 - EXECUTION

3.01 TESTING

- A. Examine installed work and conditions under which testing is to be done to ensure that work has been completed, cleaned and is operable. Do not proceed with TAB work until unsatisfactory conditions have been corrected in manner acceptable to Tester. Before initiating balancing work, Contractor shall verify that systems are complete and operable. Ensure the following:
 1. Equipment is operable and in a safe and normal condition.
 2. Temperature control systems are installed complete and operable.
 3. Proper thermal overload protection is in place for electrical equipment.

4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 5. Duct systems are clean of debris.
 6. Correct fan rotation.
 7. Volume dampers are in place and open.
 8. Coil fins have been cleaned and combed.
 9. Access doors are closed and duct end caps are in place.
 10. Air outlets are installed and connected.
 11. Duct system leakage has been minimized.
- B. Test, adjust and balance environmental systems and components, as indicated, in accordance with procedures outlined in applicable standards.
- C. Coordinate TAB procedures with any phased construction completion requirements for the project. Systems serving completed phases of the project will require TAB for such phases prior to partial final inspections.
- D. Allow sufficient time in construction schedule for TAB and submission of reports prior to partial final inspections.
- E. Prepare report of test results, including instrumentation calibration reports, in format recommended by applicable standards. Draft report shall be sent to Design Professional for review prior to issuance to Owner.
- F. Patch holes in insulation, ductwork and housings, which have been cut or drilled for test purposes, in manner recommended by original Installer.
- G. Mark equipment settings, including damper control positions, fan speed control levers, and similar controls and devices, to show final settings at completion of TAB work. Provide markings with paint or other suitable permanent identification materials.
- H. Prepare a report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced; including, where necessary, modifications which exceed requirements of contract documents for HVAC work.
- I. The test and balance agency shall perform the following tests and balance the air system in accordance with the following requirements (provide written substantiating data):
1. Test, adjust and record all blower RPM at design requirements.
 2. Make pitot tube transverse of main supply ducts and obtain design CFM at all fans and blowers.
 3. Test and record all system static pressures, suction and discharge.
 4. Test and adjust all systems for design CFM of recirculated air.
 5. Test and adjust all systems for design CFM of outside air.
 6. Test and record entering and leaving air temperatures (DB and WB); all air units.
 7. Adjust all zones to proper design CFM, supply and return.
 8. Test and adjust each diffuser, grille and register within 10% design requirements.
 9. In reading and tests of diffusers, grilles and registers, include design velocity and final velocity, when required, and design CFM and final CFM after adjustments.
 10. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.
 11. Balance fume hoods for design flow rate/face velocity, including calibration of face velocity sensors.
 12. In cooperation with the control manufacturer's representative, set adjustments of all controllers to operate as specified, indicated and/or noted.
 13. Flow Rate Tolerances:
 - a. Applications which do not require differential pressure control: -10% to +10%.
 - b. Applications which require differential pressure control:
 - 1) Positive zones
 - a) Supply air: 0 to +10%
 - b) Exhaust and return air: 0 to -10%

- 2) Negative zones
 - a) Supply air: 0 to -10%
 - b) Exhaust and return air: 0 to +10%
 - c. Minimum outside air: 0 to +10%
- 14. Coordinate locations of volume dampers with the mechanical contractor as required to balance the entire system.
- 15. Unless noted otherwise balance all domestic hot water circulation valves to 0.5 gpm.
- J. Where balancer has a question regarding appropriate system configuration for balancing, balancer should contact Design Professional for clarification.

END OF SECTION 23 05 93

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SECTION 23 07 00
HVAC INSULATION

PART 1 - GENERAL

1.01 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this Section.

1.02 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary to install insulation to all hot and cold surfaces of piping, ductwork, tanks, fittings and other surfaces as required by the drawings and this section.
- B. Insulation shall include insulating materials, jackets, adhesive, mastic coatings, tie wire and other materials as required to complete the insulating work.

1.03 DEFINITIONS

- A. Conditioned Space: An area inside the building which is heated and/or cooled.
- B. Tempered Space: An area inside the building which is not directly heated or cooled, but is adjacent to a heated or cooled space with no insulation separating the two spaces (e.g., ceiling plenums).
- C. Untempered Space: An area inside the building which is not conditioned and is not tempered (e.g., attic spaces).
- D. Exterior Space: An area outside the building including thickness of roof/insulation and exterior wall construction. (e.g., roof mounted items).

1.04 QUALITY ASSURANCE

- A. NFPA Compliance: Insulating materials, jackets, mastics, etc., shall meet flame spread and smoke developed ratings in accordance with NFPA-90A. Flame spread rating of not more than 25, smoke developed rating of not more than 50 as tested by ANSI/ASTM E84 (UL 723) (NFPA 255) method. All accessory items such as PVC jacketing and fittings, adhesive, mastic, cement tape and cloth shall have the same component ratings as specified above.
- B. Installation of insulation materials shall be in accordance to the latest edition of MICA/NIAC National Commercial & Industrial Standards for the appropriate material application.
- C. NFPA Compliance: Fire Barrier Duct Wrap systems shall meet requirements of NFPA 96 for grease duct application.

1.05 SUBMITTALS

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

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard ratings of products.
- B. Protect insulation against dirt, water, and chemical and HVAC damage. Do not install damaged insulation; remove from project site.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Insulating Materials
 - 1. Owens/Corning Fiberglass Corp.

2. Armacell.
3. Pittsburgh Corning Corp.
4. CertainTeed Corp.
5. Knauf Fiber Glass
6. John's-Manville Corp.
7. Aeroflex

B. Mastics and adhesives as recommended by insulation manufacturer.

2.02 PIPE INSULATION

- A. Type 'A': Preformed sectional heavy density fiberglass insulation and factory applied vapor barrier, all service jacket with pressure sensitive self-sealing longitudinal laps and butt strips. Suitable for operating temperatures from 0 to +850 deg. F. Thermal conductivity shall be no greater than 0.23 Btu-in/hr-sq.ft.-deg F @ 75 deg. F mean temperature. Water vapor permeance of .02 perms. Equal to Owens Corning 25 ASJ/SSL.
 1. Where insulation is exposed to weather outdoors it shall be covered with an aluminum or stainless steel weatherproof jacket 0.016" thick and sealed.
 2. Where insulation is exposed in indoor occupied space and within 8 feet of finished floor, it shall be covered with 30 mil PVC jacket equal to Johns Manville Zeston.
- B. Type 'B': Flexible elastomeric extruded pipe covering, 6 pound density, 0.27 K factor, water vapor permeance of 0.20 perms. Suitable for temperature from -40 deg. F to +220 deg. F. Equal to Armacell, AP Armaflex, joints sealed with adhesive as recommended by insulation manufacturer. Exposed outdoor insulation to be finished with two coats of ArmacellArmaflex WB Finish protective coating.
 1. Where insulation is exposed to weather outdoors it shall be covered with an aluminum or stainless steel weatherproof jacket 0.016" thick and sealed.
 2. Where insulation is exposed in indoor occupied space and within 8 feet of finished floor, it shall be covered with 30 mil PVC jacket equal to Johns Manville Zeston.
- C. Type 'C': Preformed rigid hydrous calcium silicate insulation. Mechanically fastened by wiring in place using 16 gauge wire on 9" centers and covered with suitable jacketing for indoor or outdoor application. Suitable for operating temperatures +200 to +1200 deg. F. Thermal conductivity shall be no greater than 0.42 Btu-in/hr-sq.ft.-deg F @ 200 deg. F mean temperature. Equal to Owens-Corning Kaylo asbestos-free pipe insulation.
- D. Type 'D': Preformed rigid cellular glass insulation with factory applied self-sealing jacket. Suitable for operating temperatures -200 to +900 deg. F. Thermal conductivity shall be no greater than 0.29 Btu-in/hr-sq.ft.-deg F @ 75 deg. F mean temperature. Equal to Pittsburgh Corning Foamglas with Pittwrap SS Jacketing.
- E. Type 'E': Preformed sectional heavy density fiberglass insulation, absorbent hydrophilic wicking-cloth, and factory applied vapor barrier, all service jacket with evaporation holes aligned with inner wicking fabric and pressure sensitive self-sealing longitudinal laps and butt strips. Suitable for operating temperatures from 35 to +350 deg. F. Thermal conductivity shall be no greater than 0.23 Btu-in/hr-sq.ft.-deg F @ 75 deg. F mean temperature. Water vapor permeance of .02 perms. Equal to Knauf Fiber Glass PermaWick.

2.03 FITTING INSULATION

- A. Type 'A1': Fittings: Insulate with mitered segments of same insulating material as for adjacent pipe covering, or with pre-molded fiberglass wired in place and covered with all-service jacket or low smoke PVC fitting covers. Valve bodies, strainer bodies, flanges, etc.: insulate with single or multiple layers of same insulating material as for adjacent pipe covering, wired in place and covered with all-service jacket.
 1. Where insulation is exposed to weather outdoors it shall be covered with an aluminum or stainless steel weatherproof jacket 0.016" thick and sealed.
 2. Where insulation is exposed in indoor occupied space, it shall be covered with 30 mil PVC jacket equal to Johns Manville Zeston.

- B. Type 'B1': Fittings: Insulate fittings, valve bodies, strainer bodies, etc., with mitercut pipe insulation or sheet insulation of same material as pipe covering.
- C. Type 'C1': Fittings: Insulate fittings with mitered segments of pipe insulation of same material as pipe covering, wired in place and finished with a 1/4" layer of insulating cement. Valve bodies, strainer bodies, flanges, etc.: insulate with single or multiple layers of same insulating material as pipe covering, wired in place and finished with 1/4" layer of insulating cement.
- D. Type 'D1': Fittings: Insulate fittings with mitered segments of pipe insulation of same material as pipe covering, wired in place and covered with suitable jacketing for indoor or outdoor application. Valve bodies, strainer bodies, flanges, etc.: insulate with single or multiple layers of the same insulating material as pipe covering, wired in place, and covered with suitable jacketing for indoor or outdoor application.
- E. Type 'E1': Fittings: Insulate with mitered segments of same insulating material as for adjacent pipe covering, or with pre-molded fiberglass wired in place and covered. Wrap all fittings with PermaWick absorbent fabric and cover with appropriate all-service jacket or Proto PermaWick PVC jackets with factory punched evaporation holes. Valve bodies, strainer bodies, flanges, etc.: insulate with single or multiple layers of same insulating material as for adjacent pipe covering, wired in place and covered with all-service jacket. Wrap all fittings with PermaWick absorbent fabric and cover with appropriate all surface jacket or Proto PermaWick PVC jackets with factory punched evaporation holes.

2.04 EQUIPMENT INSULATION

- A. Type 'G':
 - 1. Rigid fiberglass insulation board with factory applied all service jacket. Suitable for operating temperatures of 0 to +850 deg. F. Water vapor permeance of .02 perms. Equal to Owens Corning Series 700 with 25 ASJ facing.
 - 2. Cut or miter insulation where necessary to fit the shape and contour of the equipment. On round surfaces band insulation in place with 3/4" x 0.015" thick galvanized steel bands 18" on center. On flat or irregular surfaces impale insulation over welded pins on 12" centers and secure with speed washers.
 - 3. Apply vapor seal ASJ pressure-sensitive patches at damaged areas. All insulation edges and butt joints are to be sealed with pressure-sensitive joint sealing tape to match the jacket. Apply in accordance with manufacturers recommendations.
- B. Type 'H':
 - 1. Rigid hydrous calcium silicate insulation. Suitable for operating temperatures of +200 to +1200 deg. F. Equal to Owens-Corning Kaylo asbestos free block insulation.
 - 2. Cut or miter insulation where necessary to fit the shape and contour of the equipment. Insulation shall be held in place with 3/4" x 0.015" thick galvanized steel bands 18" on center.
 - 3. Insulation shall be finished with 1/2" thickness of insulating cement, in two coats.
- C. Type 'I':
 - 1. Flexible elastomeric insulation. Suitable for operating temperatures of -40 to +220 deg. F. Equal to Armacell Armaflex II Sheet Insulation.
 - 2. Cut insulation where necessary to fit the shape and contour of the equipment. Insulation shall be installed using Armstrong 520 Adhesive.
 - 3. Exposed outdoor insulation shall be finished with two coats of Armacell Armaflex finish.

2.05 DUCT INSULATION

- A. Duct Covering: Johns Manville Microlite Standard or equivalent fiberglass duct wrap with factory applied Foil Scrim Kraft (FSK) vapor barrier jacket, 1.0 pound per cubic foot density. Provide insulation with black jacket for areas where insulation is exposed and all items are to be painted black.

- B. Rigid Duct Covering: Johns Manville or equivalent semi-rigid fiberglass insulation board with a factory applied Foil Scrim Kraft (FSK) vapor barrier jacket, three (3) pound per cubic foot density. Exterior rigid duct insulation to be covered with VentureClad 1577CW multilayered, self-adhesive jacketing system.
- C. Exterior Duct Insulation:
 - 1. Insulation board : Rigid closed cell polyisocyanurate foam with minimum nominal density of 2.0 lb/cu ft and thermal conductivity no higher than 0.19 at 75 deg F after 180 days and maximum water vapor permeability of 4 perm inch and maximum water absorption of 2% by volume. Insulation shall have minimum 24 psi parallel and 13 psi perpendicular compressive strength and rated for -250 deg F to 900 deg F.
 - 2. Jacket: Multi-layered self-adhesive water proof jacketing system. VentureClad 1577CW or equal.

2.06 INSULATION BLANKETS

- A. Interior fabric properties: 17 oz/yd² silicone coated fiberglass cloth, temperature rating of -80 degrees F to 500 degrees F.
- B. Insulation filler properties: 1" thick (unless indicated otherwise) needed fiberglass mat insulation with 11.25 lbs/ft³ density, maximum temperature rating 1,200 degrees F.
- C. Exterior fabric properties 17 oz/yd² silicone coated fiberglass cloth, temperature rating of -80 degrees F to 500 degrees F.
- D. Securement: Fourteen (14) gauge stainless steel lacing anchors with one and one half (1.5") diameter stainless steel speed washers.
- E. Sewing thread: Kevlar/stainless steel S-110 natural with stainless steel core. Steel core can withstand temperatures of approximately 1,100 degrees F, with mechanical strain.
- F. Draw cord closure: 0.125" diameter #4 ultra-strength draw cord.
- G. Identification tag: All reusable insulating blanket assemblies shall be labeled with a 1.5" x 3.5" aluminum or 304 stainless steel tag with raised imprinted lettering. The tagging systems shall facilitate installation and reinstallation of all blankets and enable replacements to be provided upon request by number assigned as imprinted on the label. Label shall include the building name (UI Museum of Art), mechanical room number, and equipment tag. Include example of planned labeling with submittal.
- H. Blankets shall be fully encapsulated and sewn, specifically shaped for the item it covers, and shall not be held together by hog ringing or wiring.
- I. Blankets shall utilize Teflon cloth belts, stainless steel double D-rings and/or Velcro straps.
- J. Blankets shall be easily removable and replaceable for maintenance.

PART 3 - EXECUTION

3.01 GENERAL

- A. Use only experienced applicators regularly engaged in the trade. Rough work will be rejected. Application details shall be in accordance with the insulating materials supplier's recommendations except where a higher standard is specified. All surface finishes shall be extended in such a manner as to protect all raw edges, cuts and surfaces of insulation.
- B. All piping shall be insulated unless specifically noted otherwise. Piping not noted in the table below shall be insulated with thicknesses matching ASHRAE 90.1 based on the fluid temperatures.

3.02 PIPE INSULATION INSTALLATION

- A. Do not insulate the following:
 - 1. Valve bonnets
 - 2. Unions in hot piping
 - 3. TC valve operators
 - 4. Hot piping within radiation enclosures or unit cabinet.
 - 5. Cold piping within unit cabinets provided piping is located over drain pan.

6. Condensate piping between steam trap and union.
7. Preinsulated expansion joints
- B. Insulate the following with insulation blankets:
 1. Condensate chests, tanks, coolers, and receivers
 2. Steam and chilled water meters
 3. Heat exchangers
 4. Pumps
 5. Air separators
 6. Side stream filters
 7. Chiller evaporator
- C. Inspect all piping and equipment before applying insulation to ensure the installing contractor has completed all leak tests, and that all surfaces are clean, dry and ready for application of insulation.
- D. Covering for "cold" pipes shall pass unbroken through hanger clevises, sleeves, etc. All details of covering for cold surfaces shall be such that continuous covering with unbroken vapor barrier and uncompressed insulation is provided as required to prevent condensation. The same covering and hanging detail shall be used for pipes connecting to vibrating equipment or carrying pulsating pressures to avoid metal contact between pipes and hangers.
- E. Insulation at removable heads, strainer plugs, and other access points shall be fabricated in such a manner that it can be readily removed without damage to the insulation. Removable insulation shall have a vapor proof cover fabricated so as to allow it to be resealed to the equipment vapor barrier.
- F. Provide rigid insulation inserts at hangers for pipes sizes 2" and larger. Inserts shall be polyisocyanurate or calcium silicate, a minimum of 180 degrees and extend 2" beyond the hanger shield. Refer to MICA Plate 1-610. Wood or plastic block hanger inserts shall not be used.
- G. Use hydraulic insulating cement anywhere insulation fibers are exposed, to fill voids, and to repair damages to the factory applied vapor barrier. Finish with material matching or compatible with adjacent jacket material.

3.03 DUCT INSULATION APPLICATION

- A. Unless specifically indicated to not be insulated, all ductwork and accessories shall be either lined or covered. Duct systems not listed or without a type or thickness indicated on the plans shall be insulated with 1-1/2" wrap.

3.04 DUCT COVERING INSTALLATION

- A. Inspect all ductwork and equipment before applying insulation to ensure the installing contractor has completed all leak tests, and that all surfaces are clean, dry and ready for application of insulation.
- B. Covering shall be cut slightly longer than circumference of duct to insure full thickness at corners. All insulation shall be adhered with edges tightly banded, and shall be adhered to duct with fire resistant adhesive. Adhesive shall be applied so that insulation conforms to duct surfaces uniformly and firmly.
- C. In addition to the adhesive, the insulation shall be additionally secured to the bottom of all ducts 18" or wider by means of grip nails and speed clips. The protruding ends of the pins shall be cut off flush after the speed clips have been applied. The vapor barrier facing shall be thoroughly sealed with a vapor barrier mastic and tape where the pins have pierced through.
- D. Insulation for "cold" ducts and accessories shall pass unbroken through hangers, sleeves, fire dampers, flexible connectors, reheat coils, etc. as required to prevent condensation. All details of covering for cold surfaces shall be such that continuous covering with unbroken vapor barrier and uncompressed insulation is provided. The same covering and hanging detail shall be used for ducts connecting to vibrating equipment or carrying pulsating pressures to avoid metal contact between ducts and hangers. Insulation Contractor shall be responsible for coordination with equipment suppliers as required to ensure continuous covering of unlined equipment components, i.e., VAV terminal unit supply collar and exposed reheat coil u-bends, fan coil unit discharge, etc.

- E. Insulation at all access points shall be fabricated in such a manner that it can be readily removed without damage to the insulation. Removable insulation shall have a vapor proof cover fabricated so as to allow it to be resealed to the equipment vapor barrier.
- F. Exterior ductwork foam board insulation shall be installed in multiple layers with staggered joints/seams. Slope top insulation on top of rectangular ductwork to provide proper drainage as required by jacketing manufacturer.

3.05 PIPE INSULATION APPLICATION

*******NOTE: Not all services apply – refer to plans for scope of services. *******

<u>Service</u>	<u>Type Insulation and Thickness*</u>
<u>Above Ground Piping</u> Hot water heating lines, supply and return, condenser water for building heating	Type A and A1: 1-1/4" and smaller - 1-1/2" thick 1-1/2" and larger - 2" thick Type C and C1: 1-1/4" and smaller – 2-1/2" thick 1-1/2" to 6" - 3" thick 8" and larger – 4" thick
Chilled water, heat pump water lines, evaporator water, ground water, well water, system make-up water	Type A and A1: 6" and smaller – 1" thick 8" and larger – 1-1/2" thick Type B and B1: 6" and smaller – 1" thick 8" and larger – 1-1/2" thick Type E and E1: 6" and smaller – 1" thick 8" and larger – 1-1/2" thick
Condensing appliance flue pipe in un-heated spaces	Type A and A1: All pipe sizes – 1-1/2" thick Type B and B1: All pipe sizes – 1" thick
Condensate drain lines	Type A and A1: 1" thick for all pipe sizes.
Heat exchangers condensate receivers, air separators, Buffer Tank	Type G: 2" thick. Type H: 3-1/2" thick
Refrigeration piping	Type B and B1: 3/4" and smaller – 3/4" thick 7/8" to 1-5/8" – 1" thick 2-1/8" and larger – 1-1/2" thick
Chiller evaporator Chilled water or two-pipe system pump volutes	Type I – 1" thick
* Insulation type and thickness indicated in table apply for all pipe materials. **For piping exposed to outdoor ambient temperatures, increase thickness by 1/2"	

END OF SECTION 23 07 00

SECTION 23 09 00
BUILDING AUTOMATION SYSTEM (BAS)

PART 1 - GENERAL

1.01 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements Division 22 – Plumbing, Division 23 – HVAC, Division 26 – Electrical, Division 27 – Telecommunications, and Division 28 – Electronic Safety and Security are applicable to work required of this section.
- B. Coordination:
 - 1. Coordination Required by BAS Contractor: The BAS Contractor shall provide all required information, material, direction and installation instructions to the designated contractor as required to allow this work to be completed in a timely/cost effective manner. This includes, but is not limited to, the following:
 - a. Coordinate with General Contractor prior to the start of construction:
 - 1) Locations of all sensors and devices located in CMU walls, concrete walls, concrete slabs, pre-cast walls, etc. Where shop drawing(s) are provided for these items, the locations shall be shown on the submitted shop drawing(s).
 - b. Coordinate with the HVAC and Plumbing Piping Contractor prior to the installation of piping on site:
 - 1) Locations of and pipe size transitions for all sensors, control valves, etc., ensuring accurate readings/operation and required access.
 - 2) Locations of flow measuring stations meeting the installation requirements for straight lengths of pipe upstream and downstream of the WFMS for the specific piping arrangement.
 - c. Coordinate with Sheet Metal Contractor prior to the submittal of ductwork shop drawings:
 - 1) Locations of all sensors, dampers, etc., ensuring accurate readings/operation and required access.
 - 2) Locations of airflow measuring stations (AFMS) meeting the installation requirements for straight lengths of duct upstream and downstream of the AFMS for the specific ductwork arrangement.
 - d. Coordinate with Testing and Balancing Contractor:
 - 1) Provide support and coordination with Testing and Balancing (TAB) Contractor for all interfaces between controls and TAB scope of work. Provide all devices and timely access to the BAS for TAB Contractor use in completing TAB procedures.
 - e. Coordinate with Electrical Contractor:
 - 1) Quantities and locations for line voltage power requirements for powering BAS panels and devices.
 - 2) If additional line voltage power is required for the operation of the BAS beyond the scope shown on the plans, it is the BAS Contractor's responsibility to provide the additional power; however, this work shall be performed by a qualified Electrical Contractor in accordance with the requirements of Division 26 specifications and included in the BAS Contractor's bid.
 - 3) Quantities and locations of additional junction boxes required for controls components installed in electrical wiring systems (e.g., current sensor, relays, etc.).
 - f. Coordinate with Telecom Contractor:
 - 1) Quantities and locations of information outlet(s).

- 2) If additional information outlets are needed beyond the quantity shown on the plans, it is the BAS Contractor's responsibility to provide these additional outlets. This work shall be performed by a qualified Telecom Contractor in accordance with Division 27 specifications and included in the BAS Contractors bid.
- g. Coordinate with Fire Alarm Contractor:
 - 1) Quantities and locations for all points of connection between the BAS and fire alarm system.
2. Work by Others: The following incidental work shall be furnished by the designated under the supervision of the BAS Contractor.
 - a. HVAC and Plumbing Piping Contractor shall:
 - 1) Install automatic valves, wells, flow switches, and water flow measuring stations that are specified to be supplied by the BAS Contractor.
 - 2) Install all pipe mounted BAS items including wells, paddle switches and differential pressure switches, including their isolation valves and associated tubing.
 - b. Sheet Metal Contractor shall:
 - 1) Install all automatic dampers furnished by the BAS Contractor. Assemble multiple section dampers with required interconnecting linkages and extend required number of shafts through duct for external mounting of damper actuators.
 - 2) Provide necessary blank off plates or ductwork transitions required to install dampers that are smaller than the duct size.
 - 3) Provide access door or other approved means of access through ducts for service to control equipment.

1.02 DESCRIPTION OF WORK

- A. Contractor shall furnish and install a complete fully functioning BAS including all necessary hardware and all operating and applications software necessary to perform the control sequences of operation as called for in this specification and on the plans. The BAS Contractor shall include all items not specifically itemized in these specifications that are necessary to implement, maintain, and operate the system in compliance with the functional intent of these specifications. The BAS shall be a complete system designed for use on Intranets and the Internet. Contractor shall be responsible for coordination with the Owner without disruption to any of the other activities taking place on that LAN.
- B. The BAS shall possess a fully modular architecture, permitting expansion in the future through additional controllers, sensors, actuators, etc.
- C. Manage and coordinate the BAS system work in a timely manner in consideration of the project schedule. Coordinate cooperatively with the associated work of other trades so as to assist the progress and not impede or delay the work of associated trades.

1.03 QUALIFICATIONS

- A. The control system shall be installed by competent control mechanics and electricians employed by the BAS Contractor. BAS Contractor is responsible for all work performed by their subcontractors.
- B. All bidders must be BAS Contractors in the business of installing direct digital control building automation systems for a minimum of 3 years. BAS Contractors must also have a minimum of five completed projects of similar size and complexity that have been in operation at least one year with the product line that will be used on this project. Any request for substitution must include a list of projects and completion dates to demonstrate compliance with this requirement.

- C. The BAS system shall be provided by a single source manufacturer offering a full line of controllers. This system shall be furnished, engineered, and installed by the manufacturer's local branch office or the manufacturer's locally authorized representative. BAS Contractor shall have factory trained technicians to provide instruction, routine maintenance, and emergency service within 24 hours upon receipt of request.
- D. Control system components shall be the manufacturer's latest standard of design at the time of bid and in conformance with the following applicable standards for products specified.

1.04 QUALITY ASSURANCE

- A. The building automation system and components shall meet the following regulatory requirements:
 - 1. American Society for Testing and Materials, ASTM.
 - 2. Institute of Electrical and Electronic Engineers, IEEE.
 - 3. National Electrical Manufacturers Association, NEMA.
 - 4. Electronics Industries Alliance, EIA.
 - 5. National Fire Protection Association, NFPA.
 - 6. National Electrical Code, NEC.
 - 7. American Society of Heating, Refrigeration, and Air-Conditioning Engineers, ASHRAE, (ASHRAE Standard 135 The BACnet Standard).
 - 8. American National Standards Institute, ANSI (ANSI 568 Commercial Building Telecommunications Cabling Standard).
 - 9. Underwriters Laboratory, UL (UL 916 Energy Management Systems).
 - 10. Underwriters Laboratory, UL (UL 864 Supervised Smoke Control).
 - 11. FCC Regulation, Part 15.
 - 12. Local building codes.

1.05 SUBMITTALS

- A. The following shall be submitted for approval prior to commencing construction of the BAS:
 - 1. Contractor Qualifications: Document compliance with qualification requirements listed above. Include names, email addresses, and phone numbers of the project manager, primary programmer, electrical sub-contractor, and other team members.
 - 2. BAS Design Submittal, including:
 - a. A bookmarked PDF with bookmarks for each plan sheet with title and number, each schedule, and each product cut sheet with appropriate description.
 - b. A table of contents listing sheet titles and sheet numbers.
 - c. A floor plan showing the proposed locations of all network controllers.
 - d. BAS network architecture diagrams including all controllers, repeaters, gateways, interconnections, etc.
 - e. Calculations showing that system architecture can support the minimum trending and data storage requirements of the project with a written guarantee that the final installation will meet the project trending and storage requirements.
 - f. Schematics with accurate arrangement of devices as they relate to the equipment.
 - g. Sequences and points lists as intended to be installed and programmed. A direct copy of the sequences and points lists from the plans will not be acceptable.
 - h. Points schedule for each physical point shown on the schematics, including: tag, point type, system name and display units.
 - i. Point-to-point wiring diagrams including start-stop arrangement for each piece of equipment, equipment interlocks, controller wiring terminal numbers and any special connection information required for properly controlling the HVAC equipment.
 - j. Controller schedule, including quantity, part number, description, and optional features.

- k. Control damper schedule including a separate line for each damper and a column for each of the damper attributes, including: associated system, associated equipment, part number, fail position, damper type, damper operator, blade type, bearing type, seals, duct size, damper size, damper material, mounting, and actuator type.
 - l. Control valve schedules including a separate line for each valve and a column for each of the valve attributes: associated system, associated equipment, part number, configuration, fail position, pipe size, valve size, valve type, valve material, close off pressure, capacity, valve CV, calculated CV, design pressure, actual pressure, and actuator type.
 - m. Airflow measuring station schedules including a separate line for each AFMS and a column for each of the AFMS attributes: associated system, associated equipment, part number, type, duct/fan inlet size, AFMS material, velocity range, and design airflow.
 - n. Product cut sheets including manufacturer's catalog data describing each item of control equipment or component provided and installed for the project. Cut sheets shall include performance data as applicable (e.g., valve Cv, damper pressure drops, operating range, sensor accuracy, sensor units, sensor, sensor hysteresis, sensor stability, etc.).
 - o. Product cut sheets for the operator workstation and any data storage devices including all technical specifications.
- B. The following shall be submitted for approval a minimum of two months prior to substantial completion:
- 1. Floor plan graphics.
 - 2. One sample graphic of each different equipment arrangement included on the project. Graphics that are not identical (except for equipment labels) need to be submitted as separate graphics.

1.06 SOFTWARE LICENSES

- A. Provide required copies of all licenses for software, including software licenses on local workstations and software loaded or embedded into controllers or other network devices. BAS licensing shall allow for unlimited access to the system; no restrictions shall be placed on the licensing. All software used by the Contractor to install the system or needed to operate the system to its full capabilities shall be licensed and provided to the Owner.

1.07 CLOSEOUT REQUIREMENTS

- A. Provide instructions on how to calibrate all sensors on the project. If a sensor cannot be field recalibrated but has the ability for replacement calibrated parts, include a source for obtaining the replacement parts.
- B. Provide O&M Manual. Refer to 23 00 10 for Operation and Maintenance (O&M) and Owner training requirements. Include the following:
- 1. Manufacturer's catalog data and specifications for all products and devices.
 - 2. A copy of all device calibration reports and certifications (e.g. NIST).
 - 3. Certificate of Demonstration for Owner training on the BAS as specified in section 23 01 00.
 - 4. Owner instruction manual to include the following to the Owner's satisfaction:
 - a. Instruction for all operations of the system.
 - b. Instructions on how to calibrate all sensors. If a sensor cannot be field calibrated but has the ability for replacement calibrated parts, include a source for obtaining replacement parts.
 - c. Reference table listing the addresses of all connected input points and output points. Settings shall be shown where applicable.
 - d. Instructions on how to perform programming functions.
 - e. Glossary of terms and common acronyms.

5. A copy of the warranty.
- C. Provide as-built documentation in the same format as the BAS Design Submittal, updated with all revisions and as-built conditions after the system demonstration has been performed. In the BAS graphics, include a link from the BAS to the final as-built documentation. Also include a PDF copy on the operator workstation. Provide a copy of the as-built point-to-point wiring diagrams and final programmed sequence inside each control panel enclosure. Also indicate exact installed locations on the floor plans for the following :
 1. All network controllers
 2. Fan differential pressure sensors
 3. Outdoor air temperature and/or humidity sensor
- D. Provide a warranty on the entire system, including software, hardware, and labor. Refer to 23 00 10 for warranty requirements. Provide an extended five (5) year warranty on all control valves and control valve actuators.
 1. In the last month of the warranty period, all BAS software and controller firmware, software, drivers, etc., shall be upgraded and validated to the latest release (version) in effect at the end of the warranty period.
 2. At the end of the warranty period, the final version of all BAS software and programming shall be fully backed up on external storage device(s) (e.g. CD, USB drive, etc.). Include all software licenses. Turn the external storage device over to the Owner.

1.08 PRE-PROGRAMMING DESIGN REVIEW MEETING

- A. Prior to starting programming, a design review meeting shall be scheduled with the Design Professional. The agenda of this meeting will be to discuss the design intent, review all systems requiring control, review naming conventions, and answer any questions the Temperature Controls Contractor may have.

1.09 DESIGN PROFESSIONAL BAS ACCESS

- A. The BAS Contractor shall provide BAS access to the Design Professional prior to substantial completion or the date of the final punch list, whichever occurs first. This shall include a username and password unique to the Design Professional.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, acceptable manufacturers are as follows:
 1. Johnson Controls – Johnson Controls, Inc., Cedar Rapids Branch Office for Ambulance/Medical Examiner Building only. Not eligible for Admin or HHS buildings.
 2. Schneider Electric – Control Installations of Iowa, Inc. (CI3), Cedar Rapids Branch Office
 3. Schneider Electric – Baker Group
 4. Distech Controls – Woodman Controls Company
 5. Honeywell – Northwest Mechanical, Inc.
 6. Trane Controls – Des Moines Trane

2.02 SYSTEM ARCHITECTURE

- A. The complete electronic BAS system may be comprised of the following levels of control devices.
 1. Operator Workstation includes the hardware and software necessary for an operator to interface with the control system.
 2. Central File Server shall store all data required by the system and be permanently connected to the network.
 3. Network Controller(s) are used for high level global programming functions and system networking.
 4. Local Controllers are for control of large primary HVAC systems such as air handling systems, heating hot water systems and chilled water systems.
 5. Application Specific Controllers are dedicated for specific equipment such as VAV boxes, fan coils, and heat pumps.
 6. Repeaters are used for communication signal enhancement along the Tier 2 network.

7. Gateways are used to allow communication between two different communication protocols.
 8. Network thermostats dedicated to specific equipment such as VAV boxes, fan coils, or heat pumps, etc.
 9. Field devices include, but are not limited to, electronic sensors, valves, actuators, switches, relays, and transducers.
 10. Tier 1 level network is the main backbone of the system and shall be an Ethernet Local Area Network (LAN). All network controllers, the Operator Workstation, and the Central File Server shall be connected directly to this network without the need for gateway devices.
 11. Tier 2 level networks are the communication busses managed by the network controllers. Local Controllers and Application Specific Controllers shall reside on a Tier 2 communication bus without any third-party controllers. All third-party controllers shall reside on a Tier 2 communication bus dedicated to third-party controllers.
- B. Data throughout any level of the network shall be available to and accessible by all other devices, controllers, the Central File Server, and the Operator Workstation.
 - C. Interruptions or faults at any point on the network shall not interrupt communications between other nodes on the network.
 - D. The BAS network shall support both copper and optical fiber communication media.
 - E. All line drivers, repeaters, signal conditioners, etc., shall be provided as necessary for proper data communication.
 - F. The system shall use the same application programming language for all levels.
 - G. The system shall be configured as a distributed processing network(s) capable and shall be scalable and expandable at all levels of the system using the same software interface and the same types of controllers. Systems that require replacement of either the workstation software or any controllers to expand the system shall not be acceptable.

2.03 OPERATOR WORKSTATION

2.04 OPERATOR INTERFACE

- A. General: The BAS operator interface shall be user friendly, readily understood and shall make maximum use of colors, graphics, icons, embedded images, animation, text based information and data visualization techniques to enhance and simplify the use and understanding of the BAS system by authorized users at the Operator Interface.
 1. User access to the BAS system shall be protected by a flexible and Owner redefinable software-based password access protection. Password protection shall be multi-level (minimum of 4 levels) and partitionable to accommodate the varied access requirements of different user groups. Provide the means to define unique access privileges for each individual authorized user. Also provide the means to establish general password groups to which an individual will then be assigned. Once assigned to the group each individual will assume all the capabilities and restrictions of that group. Provide the means to manage individual user password and access privileges under the control of a master password.
 2. The operator interface shall be able to combine data from any and all of the system components in a single browser window. This shall include historical data stored on a server.
 3. The operator interface shall incorporate comprehensive support for functions including, but not necessarily limited to, the following:
 - a. User access for selective information retrieval and control command execution.
 - b. Monitoring and reporting.
 - c. Alarm, non-normal, and return to normal condition annunciation.
 - d. Selective operator override and other control actions.
 - e. Information archiving, manipulation, formatting, display and reporting.
 - f. BAS internal performance supervision and diagnostics.

- g. On-line access to user HELP menus.
 - h. On-line access to current BAS as-built records and documentation.
 - i. Means for the controlled re-programming, re-configuration of BAS operation and for the manipulation of BAS database information in compliance with the prevailing codes, approvals and regulations for individual BAS applications.
4. Provide BAS reports and displays making maximized use of simple English language descriptions and readily understood acronyms, abbreviations and the like to assist user understanding and interpretation.
 5. All text naming conventions shall be consistent in their use and application throughout the BAS and coordinated with Owner preference.
- B. Web Interface
1. The system shall be capable of supporting clients using a standard web browser such as Internet Explorer™. Systems requiring additional software (to enable a standard Web browser) are not acceptable.
 2. The web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the graphical user interface on the operator workstation. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be acceptable.
 3. The web browser client shall support at a minimum, the following functions:
 - a. User log-on identification and password shall be required. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
 - b. Users shall have administrator-defined access privileges.
 - c. The system shall provide the capability to specify a users home page. Provide the ability to limit a specific user to just their defined home page. From the home page links to other views, or pages in the system, shall be possible if allowed by the system administrator.
 - d. Graphical screens developed for the operator interface shall be the same screens used for the web browser client. Any animated graphical objects supported by the operator workstation software shall be supported by the web browser interface.
 - e. HTML programming shall not be required to display system graphics or data on a web page. HTML editing of the web page shall be allowed if the user desires a specific look or format.
 - f. Real-time values displayed on a web page shall update automatically without requiring a manual “refresh” of the web page.
 - g. Graphic screens on the web browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.
- C. Alarms: Alarms shall be routed directly from network controllers to the operator workstation and/or servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers. The alarm management portion of the operator interface software shall, at the minimum, provide the following functions:
1. The BAS shall annunciate diagnostic alarms, at a minimum, indicating system failure, individual controller failure, individual component failure, and non-normal operating conditions.
 2. Any attribute of any object in the system may be designated to report an alarm.
 3. Log date and time of alarm occurrence.
 4. Generate a “pop-up” window, with audible alarm, informing a user that an alarm has been received.
 5. Allow a user, with the appropriate security level, to acknowledge, temporarily silence, or discard an alarm.

6. Provide an audit trail on hard drive for alarms by recording user acknowledgment, deletion, or disabling of an alarm. The audit trail shall include the name of the user, the alarm, the action taken on the alarm, and a time/date stamp.
 7. Provide the ability to direct alarms to an e-mail address or phone number via text message. This must be provided in addition to the pop up window described above. Systems which use e-mail and/or text messaging as the exclusive means of annunciating alarms are not acceptable.
- D. Reports: Reports shall be generated and directed to one or more of the following: operator interface displays or an archive at the user's option. As a minimum, the system shall provide the following reports:
1. All points in the BAS system.
 2. All points in each BAS application.
 3. All points locked out or overridden in a BAS application.
 4. All points currently in alarm in a BAS application.
 5. All BAS schedules.
 6. All user defined and adjustable variables, schedules, interlocks, etc.
 7. BAS diagnostic and system status reports.
- E. Navigation Tree: The system shall have an intuitive and easy to navigate collapsible and expandable navigation tree. Requirements of the navigation tree shall include:
1. A dedicated folder where links to all graphics are located. In systems with many different graphics, locate similar equipment graphics in a sub-folder (e.g., VAVs for Level 1 in a sub-folder).
 2. A grouping of all systems/equipment/points by the network controller and communication bus it resides on. All systems and equipment shall match the names indicated on the plans.
 3. A minimum of 5 collapsible and expandable levels.
 4. Links to long-term trends.
 5. Links to all alarms and alarm history logs.
 6. Ability for the operator to customize the navigation tree by defining groupings and adding any systems or points to those groups and modifying the order of groups.
 7. Ability for groups to be located within other groups.
 8. Ability to rename any group, system, or point in the navigation tree.
- F. Dynamic Color Graphics: The system shall allow for the creation of user defined, color graphic displays for the viewing of HVAC, systems, electrical systems, building schematics, etc. These graphics shall contain point information from the database including any attributes associated with the point (engineering units, etc.). In addition, users with the appropriate security level shall be able to command equipment or change setpoints from a graphic through the use of the mouse. Requirements of the color graphic subsystem include:
1. An unlimited number of graphic displays shall be able to be generated and executed.
 2. Graphics shall be based on vectorized technology and HTML5 programming language. Rasterized graphics and Java programming language are not acceptable.
 3. Values of real time attributes displayed on the graphics shall be dynamic and updated on the displays.
 4. The graphic displays shall be able to display and provide animation based on real-time BAS data that is acquired, derived, or entered.
 5. Users with the appropriate security level shall be able to change values (setpoints) and states in system controlled equipment directly from the graphic display.
 6. Provide a graphic editing tool that allows users with the appropriate security level to create and edit graphic files. It shall be possible to edit the graphics directly while they are on line, or at an off line location for later downloading to the controller.

7. BAS system shall be provided with a complete user expandable symbol library containing all of the basic symbols used to represent typical system components. Implementing these symbols in a graphic shall involve dragging and dropping them from the library to the graphic.
8. The following graphics, at a minimum, shall be provided:
 - a. Floor plan graphics showing all as constructed room numbers, zoning boundaries, zone level space sensors readings (temperature, relative humidity, occupancy, CO2, CO, etc.) and indicate accurate locations of the sensors. The floor plan graphics shall also show the as constructed location and name of all network controllers.
 - 1) All readings shall be color coded to indicate the deviation from current set point and a legend describing the colors and associated deviation scale.
 - 2) Any readings in an alarm shall flash on the graphic.
 - 3) All zones shall include a link to the zone level equipment graphic page.
 - b. Central system graphics showing all equipment and components with interconnecting piping/ductwork in schematic form. Equipment and components shall be accurately placed relative to each other on the schematic.
 - 1) Each hydronic piping system.
 - c. A graphic screen for all equipment connected to the BAS system. At a minimum, all points listed in the minimum points list on the plans shall be visible on the graphic screen.
 - 1) Include a separate graphic screen for every individual piece of equipment. Where two or more pieces of equipment are redundant (e.g. system pumps), they may reside on the same graphic screen.
 - 2) Where a reset or staging schedule is required, include the details of the reset schedule and staging schedule on the graphics. Indicate the current set point or stage as calculated by the reset or staging schedule.
 - 3) Where a software button is required by the sequence, include the software button on the graphic.
 - 4) All software points listed on the plans shall also be included on the graphic.
 - d. Where redundant equipment is set up as lead/lag, the graphic screen shall include the ability for the user to switch the lead/lag positions.
- G. Schedules: It shall be possible to configure and download all schedules within the BAS from the operator interface.
 1. The system shall provide multiple schedule input forms for automatic BAS time-of-day scheduling and override scheduling of BAS operations. At a minimum, the following spreadsheet types shall be accommodated:
 - a. Weekly schedules.
 - b. Monthly schedules.
 - c. Special "Only active if today is a holiday" schedules.
 - d. Temporary override schedules.
 2. Schedules shall be provided for each individual piece of equipment. Similar equipment on the same system shall also be able to be scheduled globally. For example, All VAVs on an AHU system shall be able to have the same schedule as the AHU or their own individual schedule for each VAV. Each schedule shall include all output points residing within the system. Each point may have a unique schedule of operation relative to the system use schedule, allowing for sequential starting and control of equipment within the system. Scheduling and rescheduling of points shall be accomplished easily via the system schedule spreadsheets.
 3. Monthly calendars for a 12-month period shall be provided that allow for simplified scheduling of holidays and special days in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the weekly schedules.

- H. Power failure and automatic restart:
 - 1. Provide for the automatic, orderly and predefined shutdown of parts or all of the BAS following total loss of power to parts or all of the BAS.
 - 2. Provide for the automatic, orderly and predefined startup and return to normal control of parts or all of the BAS following total loss of power to those parts or all of the BAS. Archive and annunciate time and details of restoration.
 - 3. Maintain the operation of the BAS real-time clock during periods of power outage for a minimum of 72 hours.
- I. Historical trending and data collection: Trend and store point data as indicated on the plans. Long-term data collection can be stored locally if memory allows or offloaded to a separate system server or hard drive. Data shall be capable of being exported in a .csv, .xls or .xlsx format or other acceptable formats for custom queries and reports using industry standard software analysis tools.
 - 1. Trend shall be capable of recording as raw data or data that is filtered where specified to be filtered before recording by the following typical filter types:
 - a. Average value.
 - b. Maximum value.
 - c. Minimum value.
 - d. Change of value (COV).
 - e. Change of state (COS).
 - f. Range – difference between minimum and maximum values.
 - 2. The software shall be able to perform the following functions on a set of user selected data:
 - a. Standard deviation.
 - b. Sum of all values.
 - c. Variance.
 - 3. Trends shall be able to be displayed in a table or graphical format. Trends shall be able to be saved in the navigation tree for future reference. The graphical display shall have the following capabilities:
 - a. Displaying multiple trends of any user selected points on one graph.
 - b. Adjust both the x-axis and y-axis scales.
 - c. Utilize multiple y-axes with unique scales and assign trends to either axis at the user's choosing.
 - d. Change trend colors, line types, and line weights.
 - e. Change display of trends between analog values and binary. Binary displays shall have the option to be displayed as a square wave.
- J. Point naming conventions and abbreviations shall be consistent with the plans and be consistent between all systems and equipment.

2.05 NETWORK CONTROLLERS

- A. General: The network controller shall be a microprocessor based, multi-tasking real time system controller that provides advanced system programming, uplink and downlink communications, polling and other supervisory functions for local and application specific controllers.
- B. Each network controller shall be classified as a BACnet compatible device, supporting the BACnet Building Controller (B-BC) profile. Controllers that support a lesser profile such as B-AAC, B-ASC, or B-SA are not acceptable. Network controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as Advanced Application Controllers (B-BC).
- C. Hardware Specifications
 - 1. Operating Environment: The controller shall be capable of operating in an environment of 32 to 122 deg F and 10 to 90% relative humidity non-condensing.
 - 2. Memory: Both the operating system of the controller, plus the application program for the controller, shall be stored in non-volatile, FLASH memory. Controllers shall contain enough memory for the current application, plus required history logging, plus a minimum of 20% additional free memory. If the controller does not have the required built-in memory capacity, a separate data storage device shall be provided.

3. Communication Ports: Each network controller shall provide communication to both the Operator Workstation(s) and the field buses. An on-board Ethernet port shall be provided.
 4. Stand-Alone: The controller shall be a true no-host system that does not require a PC or "Host" computer to perform any control functions or communications.
 5. Modular Expandability: The system shall employ a modular input/output (I/O) design to allow easy expansion. Input and output capacity is to be provided through plug-in modules. It shall be possible to combine I/O modules as desired to meet the I/O requirements for individual control applications.
 6. Real Time Clock (RTC): Each network controller shall include a battery-backed, real time clock, accurate to 10 seconds per day. The RTC shall provide the following: time of day, day of week, day, month, and year. The system shall automatically correct for daylight savings time and leap years.
 7. Power Supply: The power supply for the network controller shall be auto sensing, 120 VAC, 60 Hz power, with a tolerance of +/- 20%. Line voltage below the operating range of the system shall be considered a power outage. The controller shall contain over voltage surge protection and require no external AC power signal conditioning.
 - a. Automatic Restart After Power Failure: Upon restoration of power after an outage, the network controller shall automatically and without human intervention: update all monitored functions, resume operation based on current, synchronized time and status, and implement special start-up strategies as required.
 - b. Battery backup: The network controller shall include an on-board battery to back up the controller's RAM. The battery shall have a shelf life of over 5 years and provide accumulated backup of all RAM and clock functions for at least 30 days. In the case of a power failure, the network controller shall first try to restart from the RAM memory. If that memory is corrupted or unusable, then the network controller shall restart itself from its application program stored in its FLASH memory.
 8. Field communication ports shall be individually electrically isolated to protect against transients, spikes, and power surges. The ports shall be optically isolated from each other, the controller circuit board and from power wiring. Optical isolation shall be provided either as an integral component to the controller or provided as a separate interface device between the controller and field wiring.
 9. Failure of any network controller shall register as an alarm in the BAS.
- D. Network Controller Software
1. General: The network controller shall contain FLASH memory to store both the resident operating system and the application software. There will be no restrictions placed on the type of application programs in the system. Each network controller shall be capable of parallel processing and executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.
 2. Passwords: User access to the controller shall be protected by a flexible and Owner redefinable software-based password access protection. Password protection shall be multi-level (minimum of 4 levels) and partitionable to accommodate the varied access requirements of different user groups. Provide the means to define unique access privileges for each individual authorized user. Also provide the means to establish general password groups to which an individual will then be assigned. Once assigned to the group each individual will assume all the capabilities and restrictions of that group. Provide the means to manage individual user password and access privileges under the control of a master password.
 3. Login: A user definable login message shall be displayed every time the workstation is connected to a system controller.

4. User Programming Language: The application software shall be user programmable. This includes all strategies, sequences of operation, control algorithms, parameters, and setpoints. The source program shall be English language-based and programmable by the user. The language shall be structured to allow for the easy configuration of control programs, schedules, alarms, reports, telecommunications, local displays, mathematical calculations, passwords, and histories. The language shall be self-documenting. Users shall be able to place comments anywhere in the body of a program. Program listings shall be configurable by the user in logical groupings. Controllers that use a "canned" program method will not be accepted.
5. Help Menu: On-line location sensitive help shall be provided for each menu item, describing the consequences of making the highlighted menu selection.
6. Programming Functions: The software blocks shall provide all the necessary mathematics, logic, utility, and control functions necessary for proper sequence of control. These functions shall be contained in the network controller operating system to be available in any combination for field programming the unit through RAM memory.
 - a. Proportional, Integral plus Derivative Control (PID)
 - b. Self-tuning PID
 - c. Two position control
 - d. Digital filter
 - e. Ratio calculator
 - f. Equipment cycling protection
7. Energy Management Applications: As a minimum, the network controller shall have the ability to, but not be limited to, perform energy management strategies such as:
 - a. Time or event-based scheduling
 - b. Calendar/holiday-based scheduling
 - c. Temporary schedule overrides
 - d. Adaptive optimum start/stop
 - e. Chiller and boiler reset/optimization
 - f. Demand limiting/load shedding
 - g. Enthalpy switchover (economizer)
 - h. Temperature compensated duty cycling
 - i. CFM tracking
 - j. Temperature or pressure reset
 - k. Run time totalization
 - l. Alarm detection and dial out or email out
 - m. Night setback
 - n. Historical trending
8. Alarms: The network controller shall be capable of comparing analog and digital readings to predetermined high and low limits and annunciate each time a value enters or returns from an alarm condition. Unique high and low limits shall be supplied for each analog point in the network. The network shall be capable of suppressing selected alarm reporting when the primary equipment from which the alarm point is based is in the inactive state. The alarm features of the system controller software shall, as a minimum, provide the following:
 - a. Digital, analog, and hi/low settings and deadband
 - b. Sliding alarm limits
 - c. Conditional alarming
 - d. Alarm inhibiting through feedback loop
 - e. Fluttering alarm suppression
 - f. Separate tailored alarm messages of 70 characters each
 - g. Auto dial of any user selected alarm condition to a minimum of 25 telephone numbers
 - h. Auto email of any user selected alarm condition to a minimum of 25 email addresses

9. Trending: Each network controller shall have the capability to simultaneously trend a minimum of 60 combined points. Adjustable sampling intervals for each trend from 30 seconds to one day or on change of value/state shall be possible. Each trend shall be capable of being automatically started or stopped, based on time of day, externally sensed points, alarms, or a calculated value. Upload of trend data to the operator workstation or other memory storage device shall be automatically performed at any time during the sampling period. The uploaded trend data shall be fully compatible with Microsoft Excel.
10. On-Line Testing: The network shall have the capability to allow the operator to design, test, and implement desired control strategies on-line.
11. Communication Diagnostics: The network controller software shall be capable of self-diagnosing failure automatically without necessary query by the operator. In the event of communications failure or limited power failure, the network shall be capable of both notifying a local operator of the specific occurrence, as well as communicating to a remote operator, either by the internet or auto dialing/emailing the condition. In addition to automatic self-diagnostics, each network controller shall maintain communications statistics on local and application specific controller communications. These statistics shall tabulate total communications attempted versus successful and unsuccessful communications by unit number. An option shall exist to reset communications statistics to zero (0) at any time.

2.06 LOCAL CONTROLLERS

- A. General: Each HVAC local controller shall be a stand-alone BAS controller. The local controllers shall be a local control loop microprocessor-based controller installed at each HVAC system (e.g., air handling unit, heating plant, chilled water plant). Each controller shall be fully programmable, contain its own control programs and will continue to operate in the event of a failure or communication loss to its associated network controller.
- B. Each local controller provided must be a BACnet device, supporting the BACnet Advanced Application Controller (B-AAC) profile. Controllers that support a lesser profile such as B-ASC or B-SA are not acceptable. Local controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as Advanced Application Controller(B-AAC).
- C. Hardware:
 1. Operating Environment: The controller shall be capable of operating in an environment of 32 to 122 deg F and 10 to 90% relative humidity non-condensing.
 2. Memory: Both the operating system of the controller, plus the application program for the controller, shall be stored in non-volatile, FLASH memory. Controllers shall contain enough memory for the current application plus required history logging. All controllers with volatile memory shall have a battery-backup for a minimum of 72 hours. Each controller shall be addressable by a workstation or laptop.
 3. Isolation: Control, communication, and power circuits for each controller shall be individually electrically isolated to protect against transients, spikes, and power surges.
 4. Input/Output Modules: Provide with at least the minimum quantity of inputs and outputs as required by the sequence of operations and points list.
 - a. Analog inputs shall accept industry standard analog signals (4-20 mA, 0-5 VDC, 0-10 VDC, etc.).
 - b. Binary inputs shall detect contact closures.
 - c. Universal inputs shall have functionality as either an analog or binary input.
 - d. Digital outputs may be latched or momentary contact type.
 - e. Analog outputs shall have a 1% resolution over total output span of 100%.
 - f. Configurable outputs shall have functionality as either an analog or binary output.
 5. Expandability: Provide input and output expansion capability through the use of plug-in modules. At least two I/O expansion modules must be capable of being added to the base local controller.

- D. Software: Provide complete controller software to execute all HVAC system local loop controls functions.
1. Control Parameters: The software blocks in the local controller shall produce all of the necessary reverse acting and/or direct acting PI signals as required by the control sequence. The proportional and integral values which make up the PI output value shall be readable and modifiable, at the system workstation or the portable service tool to facilitate tuning of control loops.
 2. Networking: Each input, output, or calculation result shall be capable of being assigned to the system controller for system networking. The local controller shall also provide the ability to download and upload configuration data, both locally at the controller and via the BAS communications network.
 3. Scan: Controller shall continuously scan and maintain the most recent data in RAM for retrieval by a network controller, operator interface, and by the local controller software programs.
 4. Database: All field control databases shall be entered, changed or downloaded to the local controllers via a laptop or operator workstation.
 5. Auto-Calibration: All inputs shall feature an auto-calibrate function to eliminate sensing errors.
 6. Memory: Provide amount of memory required to store data until it is sent to the network controller.
 7. Programming Functions: Provide the following standard BAS loop programming functions:
 - a. Control block programming
 - b. PI or PID control
 - c. Serial load staging
 - d. Binary load staging
 - e. Analog load staging
 - f. Master-submaster routines
 - g. Anti-windup for integrated loops
 8. Real Time Clock (RTC): All local controllers shall have a real time clock in either hardware or software. The accuracy shall be within 10 seconds per day. The RTC shall provide the following information: time of day, day, month, year, and day of week. Each local controller shall receive a signal, every hour, over the network from the network controller, which synchronizes all local controllers' real time clocks.
- E. Failure Operation:
1. Automatic Restart After Power Failure: Upon restoration of power after an outage, the controller shall automatically and without human intervention: update all monitored functions, resume operation based on current, synchronized time and status, and implement special start-up strategies as required.
 2. Stand-Alone Operation During Network Communication Failure: Controllers requiring the application or database to be downloaded from a host or share processing with a network controller shall not be acceptable. During a communication failure the application specific controller must run the control application using the current setpoints and configuration.
 3. Failure of any local controller shall register as an alarm in the BAS.

2.07 APPLICATION SPECIFIC CONTROLLERS

- A. General: Each HVAC application specific controller shall be a stand-alone BAS controller. The controller shall include all hardware and software required for communications with the network controller. Unless noted otherwise, an individual application specific controller shall be dedicated for each terminal device.
- B. Each application specific controller provided must be a BACnet device, supporting the BACnet Application Specific Controller (B-ASC) profile. Controllers that support a lesser profile such as B-SA are not acceptable. Local controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as Application Specific Controllers (B-ASC).

- C. Hardware:
 - 1. Operating Environment: The controller shall be capable of operating in an environment of 32 to 122 deg F and 10 to 90% relative humidity non-condensing.
 - 2. Input/Output Modules: Provide with at least the minimum quantity of inputs and outputs as required by the sequence of operations and points list.
 - a. Analog inputs shall accept industry standard analog signals (4-20 mA, 0-5 VDC, 0-10 VDC, etc.).
 - b. Binary inputs shall detect contact closures.
 - c. Universal inputs shall have functionality as either an analog or binary input.
 - d. Digital outputs may be latched or momentary contact type.
 - e. Analog outputs shall have a 1% resolution over total output span of 100%.
 - f. Configurable outputs shall have functionality as either an analog or binary output.
 - 3. Expandability: Provide input and output expansion capability through the use of plug-in modules. Where additional inputs or outputs are required for the specified application, provide the expansion module with the application specific controller.
- D. Software:
 - 1. Programming: The control program shall reside in the application specific controller. The application program shall be maintained in read only memory (ROM). The default database, i.e. setpoints and configuration information, shall be stored in electrically erasable programmable read-only memory (EEPROM). Controllers requiring local setting of potentiometers or dip switches are not acceptable for programming functions. Dip switches for creating unique addresses for controllers are acceptable.
 - 2. Auto-Calibration: All inputs shall feature an auto-calibrate function to eliminate sensing errors.
- E. Failure Operation:
 - 1. Automatic Restart After Power Failure: Upon restoration of power after an outage, the controller shall automatically and without human intervention: update all monitored functions, resume operation based on current, synchronized time and status, and implement special start-up strategies as required.
 - 2. Stand-Alone Operation During Network Communication Failure: Controllers requiring the application or database to be downloaded from a host or share processing with a network controller shall not be acceptable. During a communication failure the application specific controller must run the control application using the current setpoints and configuration.
 - 3. Failure of any application specific controller shall register as an alarm in the BAS.

2.08 REPEATERS AND SIGNAL CONDITIONERS

- A. Provide a repeaters and signal conditioners at locations in the controls network where required.

2.09 GATEWAYS

- A. Provide a gateway at all points of connections of dissimilar controls networks/protocols. The gateway shall permit the exchange of all specified and required information between the two dissimilar networks/protocols.

2.10 FIELD DEVICES

- A. Multi-Purpose Sensors:
 - 1. All multi-purpose or combination sensors shall meet all requirements listed below for the individual sensors that are being combined into one unit.
 - 2. Sensors are only allowed to be combined if shown in the exact same location on the controls schematics, HVAC plans, or elevations with no components between them.
- B. Temperature Sensors:
 - 1. General:
 - a. All temperature devices shall use precision thermistors or RTD sensors accurate to +/- 1 degree F over a range of -30 to 230 degrees F, unless indicated otherwise.

2. Space Sensors and/or Thermostats:
 - a. Sensors shall be available in an off-white ventilated enclosure, unless noted otherwise on the plans. Sensor shall be able to be mounted on a standard electrical box.
 - b. The sensor housing shall feature both a mechanism for adjusting the space temperature set point and/or a push button for selecting after hours occupied operation.
 - c. The sensor shall incorporate either an LED or LCD display for viewing the space temperature, set point, and other operator selectable parameters. Using built in buttons, operators shall be able to adjust set points directly from the sensor. Resolution shall be as indicated on the plans.
 - d. Minimum sensing range shall be 32 to 100 deg. If a space is being controlled to a set point outside of this range, then a sensor appropriate for the application shall be provided.
 - e. All sensors shall be the same appearance in the occupied and public areas of the building, but may have different options as required (set point adjustment, override button, etc.). Exceptions that would allow a different appearance include mechanical rooms, electrical rooms, storage rooms, vestibules, etc.
 3. Duct Sensors: Sensors shall incorporate a thermistor bead embedded at the tip of a stainless-steel tube. Wiring shall terminate in a galvanized steel box at the end of the probe, except where wiring factory provided wiring can be connected to a controller without additional wiring. Probe style duct sensors are required in air handling applications where the coil or duct area is less than 14 square feet.
 - a. For duct widths 12" or less, use a minimum 4" probe.
 - b. For duct widths between 13" and 24", use a minimum 8" probe.
 - c. For duct widths larger than 24", use a minimum 12" probe.
 4. Averaging Temperature Sensors: Sensors shall be employed in ducts which are larger than 14 square feet. The length of flexible copper tubing shall cover no more than one square foot of face area per one linear foot of sensing element length. The maximum length of the copper tube for one device shall be 24 ft. Where a longer length is required, multiple sensors shall be provided and the average temperature calculated by software programming.
 5. Immersion Sensors: Sensors shall be employed for measurement of temperature in all hydronic, domestic water, and refrigerant piping applications. Thermal wells shall be brass or stainless steel for non-corrosive fluids below 250 degrees F and 300 series stainless steel for all other applications. Wiring shall terminate in a galvanized steel box at the end of the probe. The length of the probe shall extend into the pipe so the end of the probe is in the middle third of the pipe. Use for all water temperature sensors on all pipe sizes 2" and larger, unless indicated otherwise on the controls schematics.
 6. Pipe Surface Mount Temperature Sensors (Strap-on): Use on all pipe sizes 1-1/2" and smaller or where specifically indicated on the controls schematics.
 7. Freezestats: Low limit temperature sensors with manual reset and capillary tube that senses the lowest temperature along the length of the capillary. The length of the capillary tube shall cover no more than one square foot of face area per one linear foot of capillary tube length. Where long lengths are required, provide multiple freezestats. The sensor shall be adjustable throughout the entire temperature range of 15 to 55 deg F.
 8. Outdoor Air Sensors: Provide with weather shield to protect against solar radiation and precipitation with multiple discs/shields over the probe to allow for good airflow and accurate readings even if mounted in direct sunlight. Minimum sensing range shall be from -40 to 140 deg F.
- C. Humidity Sensors:
1. Space Sensors:
 - a. Humidity sensors shall be of the solid-state type using a hygroscopic polymer or thin film capacitive sensing element.

- b. Sensors shall be available in an off-white ventilated enclosure, unless noted otherwise on the plans. Sensor shall be able to be mounted on a standard electrical box.
 - c. Accuracy: +/- 3% over a range of 0-90% non-condensing.
 - d. Stability: +/- 1% annually over 2 years.
 2. Duct and/or Air Moving Equipment Sensors:
 - a. Humidity sensors shall be of the solid-state type using a hygroscopic polymer or thin film capacitive sensing element.
 - b. Accuracy: +/- 3% over a range of 0-90% non-condensing.
 - c. Stability: +/- 1% annually over 2 years.
 - d. Where installed in high velocity ductwork, provide an element guard.
 3. Outdoor Air Sensors:
 - a. Provide with weather shield to protect against solar radiation and precipitation with multiple discs/shields over probe to allow for good airflow and accurate readings even if mounted in direct sunlight.
 - b. Accuracy: +/- 2% over a range of 0-90% non-condensing.
 - c. Stability: +/- 1% annually.
 4. All humidity sensors shall be able to be recalibrated in the field or the sensing tip to be replaced without replacing the entire sensor.
 - D. Differential Pressure Sensor: Differential pressure sensor shall be temperature compensated and shall vary the output voltage with a change in differential pressure. Sensor shall have a non-repeatability of +/- 0.05% of range. Sensor shall be capable of withstanding up to 150% of rated pressure without damage.
 1. Duct differential pressure sensors shall have an appropriate range for the application with a minimum accuracy of +/- 1% of range.
 - a. Sensors in positively pressurized ductwork (typically downstream of the supply fan) shall only have a positive range.
 - b. Sensors in negatively pressurized ductwork (typically upstream of a fan) or between fans in series (typically in an air handling unit) shall have both a negative and positive range.
 2. Room differential pressure sensors shall have a range of -0.25" w.c. to 0.25" w.c. and a minimum accuracy of +/- 0.5% of range.
 3. Underfloor plenum differential pressure sensors shall have a range of 0" w.c. to 0.25" w.c. and a minimum accuracy of +/- 0.5% of range.
 4. Building differential pressure sensors shall have a range of -0.25" w.c. to 0.25" w.c. and a minimum accuracy of +/- 0.5% of range. Sensor shall be provided with a pressure sensing tip that incorporates a shield to minimize the effect of wind.
 5. Water differential pressure sensors shall be accurate to +/- 0.5% of range. The housing shall be NEMA 4 rated.
 6. Steam and gas differential pressure sensors shall be accurate to +/- 0.5% of range. The housing shall be NEMA 4 rated.
 - E. Air Differential Pressure Switches: Differential pressure switches shall be field adjustable with a range appropriate for the duct pressure classification and include manual reset. The switch shall be capable of withstanding up to 150% of rated pressure without damage. Provide a red pilot lighted reset button located on the control panel that is wired to the manual reset from the switch.
 - F. Airflow Measuring Stations (AFMS):
 1. General:
 - a. All AFMSs shall be manufactured by Ebtron.
 - b. Provide a thermal anemometer using instrument grade self-heated thermistor sensors with thermistor temperature sensors.
 2. Duct-Mounted Air Flow Measuring Stations (Duct sizes 16" or less in any direction):
 - a. Airflow measuring stations to be Ebtron Model ELF/F. Each device shall consist of two independent sensor nodes in a single probe assembly for ducts from 5" to 16" and a single sensor node for 4" ducts.

- b. Each sensing node shall independently determine the airflow rate, which shall be equally weighted in calculations by the transmitter prior to output as the average for the duct and be linear to flow.
 - c. Each device shall have a certified accuracy of +/-3% of reading over the entire calibrated airflow range of 0 to 3,000 fpm, including repeatability of 0.25% of reading.
 - d. Analog output resolution shall be equal to or better than 0.015% full-scale.
 - e. Each device shall be individually wind tunnel calibrated as an assembly to volumetric airflow standards. The design shall include compensation for flow losses to eliminate inaccuracies associated with airflow measurement in small ducts.
 - f. Required Environmental Operating Range
 - 1) The transmitter operating temperature range shall be at least -20° F to 120° F.
 - 2) The sensor probe operating temperature range shall be at least -20° F to 160° F.
 - 3) The operating humidity range shall be at least 0 to 99% (non-condensing).
 - g. Probes shall be constructed of extruded 6063 aluminum tubes or of Type 316 stainless steel tubes.
 - h. The transmitter shall be capable of field configuration and diagnostics and identifying a faulty sensor node, ignore it and continue to operate by correctly averaging the remaining sensor node.
3. Duct-Mounted Air Flow Measuring Stations (Duct sizes up to and including 2 square feet):
- a. Airflow measuring stations to be Ebtron Hybrid Series HTx104-P. Each device shall consist of four independent sensor nodes in a number of probes required for the application.
 - b. Each sensing node shall independently determine the airflow rate, which shall be equally weighted in calculations by the transmitter prior to output as the average for the duct and be linear to flow.
 - c. Each device shall have a certified accuracy of +/-2% of reading over the entire calibrated airflow range of 0 to 5,000 fpm, including repeatability of 0.25% of reading.
 - d. Analog output resolution shall be equal to or better than 0.025% full-scale.
 - e. Each device shall be individually wind tunnel calibrated as an assembly to volumetric airflow standards. The design shall include compensation for flow losses to eliminate inaccuracies associated with airflow measurement in small ducts.
 - f. Required Environmental Operating Range
 - 1) The transmitter operating temperature range shall be at least -20° F to 120° F.
 - 2) The sensor probe operating temperature range shall be at least -20° F to 160° F.
 - 3) The operating humidity range shall be at least 0 to 99% (non-condensing).
 - g. Probes shall be constructed of gold anodized extruded 6063 aluminum tubes or of Type 316 stainless steel tubes.
 - h. The transmitter shall be capable of field configuration and diagnostics and identifying a faulty sensor node, ignore it and continue to operate by correctly averaging the remaining sensor node.
 - i. The transmitter shall be provided with a 16-character, alpha-numeric, LCD display. The airflow rate, temperature, airflow alarm and system status alarm shall be visible on the display.
 - j. Provide with remote mounted display enclosure for mounting below 7 ft in the mechanical room.

4. Duct-Mounted Air Flow Measuring Stations (Duct sizes larger than 2 square feet):
- a. Airflow measuring stations to be Ebtron Gold Series GTX116-P+. Each device shall consist of up to 16 independent sensors in a number of probes required for the application. The quantity of nodes provided shall be according to the following table.

Area ft ²	# Sensor Nodes
> 2 & ≤ 4	6
> 4 & ≤ 8	8
> 8 & ≤ 12	12
> 12 & ≤ 14	14
> 14	16

- b. A total of 4 probes shall be required for openings with an aspect ratio ≥ 1.5 and with an area ≥ 25 ft².
- c. Each sensing node shall independently determine the airflow rate, which shall be equally weighted in calculations by the transmitter prior to output as the average for the duct and be linear to flow.
- d. Each device shall have a certified accuracy of +/-2% of reading over the entire calibrated airflow range of 0 to 5,000 fpm, including repeatability of 0.25% of reading.
- e. Analog output resolution shall be equal to or better than 0.025% full-scale.
- f. Each device shall be individually wind tunnel calibrated as an assembly to volumetric airflow standards. The design shall include compensation for flow losses to eliminate inaccuracies associated with airflow measurement in small ducts.
- g. Required Environmental Operating Range
- 1) The transmitter operating temperature range shall be at least -20° F to 120° F.
 - 2) The sensor probe operating temperature range shall be at least -20° F to 160° F.
 - 3) The operating humidity range shall be at least 0 to 99% (non-condensing).
- h. Probes shall be constructed of gold anodized extruded 6063 aluminum tubes or of Type 316 stainless steel tubes.
- i. The transmitter shall be capable of field configuration and diagnostics and identifying a faulty sensor node, ignore it and continue to operate by correctly averaging the remaining sensor node.
- j. The transmitter shall be provided with a 16-character, alpha-numeric, LCD display. The airflow rate, temperature, airflow alarm and system status alarm shall be visible on the display.
- k. Provide with remote mounted display enclosure for mounting below 7 ft in the mechanical room.
5. Fan Inlet Air Flow Measuring Stations:
- a. Airflow measuring stations to be Ebtron Gold Series GTX108-F. The number of independent sensor nodes provided shall be as follows:
- 1) SWSI and DWDI fans: 2 probes x 1 sensor node/per probe in each fan inlet.
 - 2) Fan Arrays (2 to 4 fans): 2 probes x 1 sensor node per probe in each fan inlet.
 - 3) Fan Arrays (5 to 8 fans): 1 probe x 1 sensor node per probe in each fan inlet.
- b. Each sensing node shall independently determine the airflow rate, which shall be equally weighted in calculations by the transmitter prior to output as the average for the duct and be linear to flow.

- c. Each device shall have a certified accuracy of +/-2% of reading over the entire calibrated airflow range of 0 to 10,000 fpm, including repeatability of 0.25% of reading.
 - d. Analog output resolution shall be equal to or better than 0.025% full-scale.
 - e. Each device shall be individually wind tunnel calibrated as an assembly to volumetric airflow standards. The design shall include compensation for flow losses to eliminate inaccuracies associated with airflow measurement in small ducts.
 - f. Required Environmental Operating Range
 - 1) The transmitter operating temperature range shall be at least -20° F to 120° F.
 - 2) The sensor probe operating temperature range shall be at least -20° F to 160° F.
 - 3) The operating humidity range shall be at least 0 to 99% (non-condensing).
 - g. Each sensor probe shall consist of one sensor node mounted on a 304 stainless steel block with two adjustable zinc plated steel rods connected to 304 stainless steel pivoting mounting feet.
 - h. The transmitter shall be capable of field configuration and diagnostics and identifying a faulty sensor node, ignore it and continue to operate by correctly averaging the remaining sensor node.
 - i. The transmitter shall be provided with a 16-character, alpha-numeric, LCD display. The airflow rate, temperature, airflow alarm and system status alarm shall be visible on the display.
 - j. Provide with remote mounted display enclosure for mounting below 7 ft in the mechanical room.
- G. Control Valves:
- 1. General:
 - a. Globe Valves shall have renewable composition discs as recommended by manufacturer for the intended service or renewable bevel seats and metal discs. Valves on steam service 4" and larger shall have ½" minimum by-pass valve and piping.
 - b. Ball Valves 2-1/2" and smaller shall be full port brass two-piece with stainless steel ball, Teflon seats and stuffing box ring with vinyl insulated lever handle. Grooved option shall be ductile iron body with stainless steel ball and stem with TFE seats and fluoroelastomer seals.
 - c. Butterfly valves 2-1/2" and larger shall be ASTM A536 ductile iron body with aluminum bronze disc, EPDM or BUNA N seat, 416 stainless stem with gear box operator and extended neck. Grooved Option shall be black enamel coated ductile iron body conforming to ASTM A536 with nickel plated ductile iron disc with blowout proof 416 stainless steel stem and EPDM seat,
 - d. Valves shall be packless and electrically actuated with true linear flow characteristics in relationship to valve opening.
 - e. Valves shall meet the heating and cooling flow rates specified and close off against the differential pressure conditions for the system in which it is installed.
 - f. Valves should be sized to operate accurately and with stability from 10 to 100% of the maximum design flow.
 - 2. Hydronic Systems:
 - a. Valves with a modulating actuator shall be sized for a 3 to 5 psi pressure drop at the design flow rate.
 - b. Valve shall be 2-way or 3-way as indicated on the plans. If there is no indication, the valve shall be 2-way.
 - c. Pressure Independent Control Valves:
 - 1) The flow through the valve shall not vary more than +/- 5% due to system pressure fluctuations.
 - 2) The rangeability of the control valve shall be a minimum of 100 to 1.

- 3) Each valve shall be provided with p/t ports on the inlet and outlet of the valve.
- 4) A flow tag shall be provided with each valve.

H. Valve Actuators:

1. Actuators shall be electronic and shall be direct coupled over the shaft, without the need for connecting linkage.
2. Actuator shall have electronic overload circuitry to prevent damage.
3. Actuators shall be available with spring return to the normal position when required or as indicated on the plans.
4. Actuators shall have a position indicator for external indication of valve position.
5. Actuators shall have manual override capability.
6. Actuators shall be quick opening or slow opening as required by the application.
7. Actuators shall be able to completely close the valve against system pressure.
8. Actuators shall be two-position or modulating as required by the sequence of operations.
9. Actuators shall be compatible with the type of valve as indicated on the plans or elsewhere in the specifications (e.g. two-way vs. three-way, ball vs. butterfly, etc.).

I. Damper Actuators:

1. Actuators shall be electronic and shall be direct coupled over the shaft, without the need for connecting linkage.
2. Actuators shall have electronic overload circuitry to prevent damage.
3. Actuators shall be available with spring return to the normal position when required or as indicated on the plans.
4. Actuators shall have a position indicator for external indication of damper position.
5. Actuators shall have manual override capability without disconnecting damper linkage.
6. Actuators shall be quick opening or slow opening as required by the application.
7. Actuators shall be able to completely close the damper against system pressure.
8. Actuators shall be two-position or modulating as required by the sequence of operations.
9. Provide the appropriate quantity of damper actuators as required by the application.

J. Position Switches: Provide switch that can sense the full closed position and an adjustable open position between 10 and 100%.

K. Current Switches: Current status switches shall be used to monitor motors and other electrical loads as indicated on the plans. Current switches shall be available in solid and split core models and offer either a digital or an analog signal to the automation system. The sensing range of the sensor shall be appropriate for the device being monitored.

L. Audible and Visible Alarms: Horn shall be continuous tone with solid-state electric signal and red LED pilot light. Provide a separate silence button (refer to manual push buttons below) to be mounted at an accessible height. The light shall remain on and the alarm condition active even after the silence button is pressed until the alarm state is resolved.

M. Pilot Lights: Light shall be LED type with push-to-test function and have an oil-tight enclosure. The light shall be green when indicating normal operation and red when indicating an issue or alarm.

N. Manual Push Buttons: Button shall be round, approximately 3/4" in diameter. Provide with the quantity and type of contacts required for the application. Submit color options for selection by the Design Professional during submittal review.

O. Manual Switches: Provide line-voltage toggle switch appropriate for the application. Refer to Division 26.

2.11 CONTROL WIRING

A. The term "control wiring" is defined to include providing of wire, conduit, junction boxes, and miscellaneous materials as required for mounting and connecting electric or electronic control devices and network communication devices.

- B. All control wiring and wiring connections required for the installation of the BAS system shall be provided by BAS Contractor unless specifically shown on the electrical or telecommunication drawings or called for in Division 26 or Division 27.
- C. All control wiring shall comply with the requirements of local and national electrical codes.
- D. Control wiring in ducts, air plenums, air moving equipment, and other air handling spaces shall be specifically listed for the use, including wiring provided with field devices.

PART 3 - EXECUTION

3.01 GENERAL

- A. Inspect and examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the installer.
- B. Install systems and materials in accordance with drawings and details, manufacturer's instructions, reviewed submittals, and contract documents. Install electrical components and use electrical products complying with requirements of applicable Division-26 sections of these specifications.
- C. Where components are installed in potentially wet or corrosive environments, install in an appropriate enclosure. Enclosures shall be of the type as indicated:
 - 1. Components installed in exterior locations or locations subject to moisture shall be installed in a NEMA 4 enclosure.
 - 2. Where possible, do not install components in corrosive environments. However, if the component must be installed in corrosive locations, it shall be installed in a NEMA 4X enclosure.

3.02 INSTALLATION OF CONTROLLERS

- A. Install controllers in accordance with manufacturer's installation instructions and with adequate clearance to allow for maintenance.
- B. Install all controllers in a control panel enclosure. Control panels shall be of the type as indicated:
 - 1. Controllers installed in interior locations shall be installed in a NEMA 1 enclosure.
 - 2. Controllers installed in exterior locations or locations subject to moisture shall be installed in a NEMA 4 enclosure.
 - 3. Where possible, do not install controllers in corrosive environments. However, if the controller must be installed in corrosive locations, it shall be installed in a NEMA 4X enclosure and all associated components shall also be appropriate for the application and shall be approved by the Design Professional prior to installation.
- C. Label all control panel enclosures with the system or equipment served. Network controllers shall be labeled to indicate the general areas of the building served. All labels shall match the designations on the as-built drawings, which shall match the equipment tags on the plans.
- D. Include a copy of the as-built point-to-point wiring diagrams and final programmed sequence inside each control panel enclosure.

3.03 INSTALLATION OF FIELD DEVICES

- A. General:
 - 1. Install all field devices where indicated on the plans and in accordance with manufacturer's installation instructions and with adequate clearance to allow for proper operation, maintenance, and removal of the device.
 - 2. Repair pipe insulation to maintain the integrity of the insulation vapor barrier. Use hydraulic insulating cement to fill voids and to repair damages to the factory applied vapor barrier. Finish with material matching or compatible with adjacent jacket material.
 - 3. Repair duct insulation to maintain the integrity of the insulation vapor barrier. Use foil tape to repair damages to the factory applied vapor barrier.

4. Where a field device penetrates a duct or air moving equipment, seal around the penetration to prevent air leakage.
- B. Room/Wall-mounted Sensors:
 1. Install at the elevation indicated on the plans.
 2. Install plastic guards over sensors with user adjustment where noted on the plans.
 3. Provide insulated back panel where sensors are located on the inside face of an exterior wall or on a column enclosure.
- C. Temperature Sensors:
 1. Averaging Temperature Sensors: Install sensing element with equal spacing to provide uniform coverage of the face area.
 2. Immersion Sensors: Coordinate the pipe size required to accept the probe diameter of the sensor without significant flow restriction with the HVAC and Plumbing Piping Contractor. All probes shall be installed in a minimum 1-1/4" pipe size.
 3. Pipe Surface Mount Temperature Sensors (Strap-on): Use only where specifically indicated on the plans. Install with thermally conductive paste at the pipe contact point. Where sensor is to be installed on an insulated pipe, install probe under the insulation and secure around pipe with only the wire protruding from insulation. Seal around wiring to maintain the vapor barrier of the pipe insulation.
 4. Freezestat: Install sensing element with equal spacing to provide uniform coverage of the face area. Adjust the low limit temperature setting as indicated on the plans or as required for the application.
 5. Outdoor Air Temperature and/or Humidity Sensors: Install in the location shown on the plans. If not shown on the plans, contact the Design Professional.
- D. Duct-mounted Relative Humidity Sensors: When installed downstream of a humidifier, install far enough downstream in airflow path to allow for full moisture absorption into the airstream at all operating conditions of the humidifier. When element guard is provided with the sensor, install upstream of the sensor.
- E. CO2 Sensors: Within one month prior to project substantial completion, calibrate all sensors. Provide calibration reports as part of the closeout documents.
- F. Differential Pressure Sensors:
 1. Duct Differential Pressure Sensors: Install in the location in the system shown on the plans. If not shown on the plans, contact the Design Professional.
 2. Water Differential Pressure Sensors: Install in the location in the system shown on the plans. If not shown on the plans, contact the Design Professional.
 3. Building Differential Pressure Sensors: Install in the location shown on the plans. Where not shown on the plans, contact the Design Professional.
- G. Air Differential Pressure Switches: For a positively pressurized duct, adjust the set point to be 0.25" less than the duct pressure classification rating. For a negatively pressurized duct, adjust the set point to be 0.25" more than the duct pressure classification rating. Unless indicated otherwise on the plans. Refer to the Duct Classification Schedule on the plans for duct pressure classification ratings.
- H. Airflow Measuring Stations (AFMS):
 1. Duct-mounted: Install in an unobstructed straight length of duct in accordance with the manufacturer's recommendations based on the duct fittings immediately upstream and downstream of the unobstructed straight length of duct.
 2. Fan inlet: Install one per fan where indicated on the plans.
 3. Where the AFMS comes with a remotely mounted display and the sensor is located in a mechanical room, the display shall also be located in the mechanical room. If the AFMS is located above a ceiling or in an occupied space, the display shall be located in the nearest mechanical, electrical, or custodial room, provided the distance is does not exceed the maximum allowed by the manufacturer. Mount the display within 7 ft AFF.

4. If the AFMS is an insertion probe-type, install in a location with enough clearance to fully remove the probe from the duct.
- I. Control Valves: Install so that the valve stem axis is vertical, with operator side up. Where vertical stem position is not possible, or would result in poor access, valves may be installed with stem horizontal. Do not install valves with stem below horizontal or down.
- J. Current Switch: Adjust so that the set point is below the minimum operating current and above motor no load current.
- K. Wall-mounted Audible and Visible Alarms: Install device at 6'-8" above finished floor. Install silence button at 46" AFF and below the audible and visible alarm.
- L. Wall-mounted Push Buttons: Install at the elevation indicated on the plans.

3.04 INSTALLATION OF CONTROL WIRING

- A. The BAS Contractor may use the building telecommunications network for Tier 1 level communication between network controllers. The BAS Contractor shall utilize the data ports indicated specifically for BAS use on the telecommunications plans. If any additional or relocated data ports are required based on the BAS Contractor's system layout, the BAS Contractor shall hire the Telecommunications Contractor to provide the additional data ports at no cost to the Owner.
- B. Any equipment specified to be on emergency power shall also have all associated controls on emergency power, including all network controllers, local controllers, devices, etc.
- C. Control wiring shall be routed in blue conduit in the following locations: concealed in walls, concealed above inaccessible ceilings, finished areas with exposed structure, inside air moving equipment or ductwork, locations subject to moisture, exterior locations, and in all unfinished spaces, such as mechanical rooms, electrical rooms, etc. Where conduit is in an exterior location or subject to moisture, it shall be rigid and sealed to be watertight. Control wiring shall not share conduit with line voltage wiring.
- D. Control wiring routed to devices in accessible locations may be routed in flexible conduit. The minimum size of the flexible conduit shall be 1/2" and the maximum length shall be 36".
- E. Control wiring concealed by accessible construction may be installed without conduit. Accessible locations include areas such as above accessible ceilings and below accessible floors. Control wiring shall not share cable tray with telecommunications wiring or raceways with any other trade. All wiring shall be neatly routed and tie-wrapped to structural components, supported at least every 4 feet. Excess wire shall be neatly coiled and secured to structure. Under no circumstances shall cable be supported by piping, conduit, ductwork, ceiling tile or ceiling support wires. Cable shall be neatly routed in line with building lines.
- F. Install all control wiring to meet all manufacturer installation requirements, including not exceeding the maximum cable length, tension, or bend radius. At all building expansion joints, provide means for movement of wiring and conduit that exceeds the expected movement of the building.
- G. Label or color code each control wire at each end. Permanently label or code each point of all field terminal strips to show the instrument or item served. Color coded cable with cable diagrams may be used to accomplish cable identification.
- H. Splices shall not be made in shielded wiring.

3.05 SYSTEM ACCEPTANCE

- A. System Verification and Testing Procedure: The BAS Contractor shall confirm the system is complete, including all controls installed, graphics complete, and software programs have been completely tested and exercised for proper equipment operation. BAS control panels shall be demonstrated via a functional end to end test such that:
 1. All output channels shall be commanded (on/off, stop/start, adjust, etc.) and their operation verified.

2. All analog input channels shall be verified for proper operation.
 3. All binary input channels shall be verified by changing the state of the field device and observing the appropriate change of displayed value.
 4. If a point should fail testing, perform necessary repair action and retest failed point and all interlocked points.
 5. Automatic control operation shall be verified by introducing an error into the system and observing the proper corrective system response.
 6. Selected time and setpoint schedules shall be verified by changing the schedule and observing the correct response on the controlled outputs.
- B. System Demonstration: After the BAS Contractor has confirmed proper operation, acceptance testing will commence at a mutually agreeable time within ten (10) calendar days of the request. At that time, the BAS Contractor shall demonstrate the operation of the system to the Owner's Representative and Design Professional. Any issues are discovered during this demonstration shall be corrected.
- C. Operation and Maintenance Manuals: Submit copies of operation and maintenance manuals as required by this section and section 23 00 10 – HVAC General Provisions.

END OF SECTION 23 09 00

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SECTION 23 31 13
METAL DUCTS

PART 1 - GENERAL

1.01 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this Section.

1.02 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary to fabricate and erect ductwork as required by the drawings and this section.
- B. Low velocity ductwork shall apply to the following:
 - 1. Supply: Downstream of terminal units.
 - 2. Return: Upstream of terminal units.
 - 3. Exhaust: Upstream of terminal units.
 - 4. Transfer & Combustion: Less than 1" static pressure.
 - 5. Outdoor & Relief: Upstream/Downstream of unit.
 - 6. Laundry Vent: Downstream of dryer.
- C. High velocity ductwork shall apply to the following:
 - 1. Supply & Ventilation: Upstream of terminal units or velocity \geq than 2,000 FPM
 - 2. Return: Downstream of terminal units and/or \geq than 2,000 FPM.
 - 3. Exhaust: Downstream of terminal units and/or \geq than 2,000 FPM.

1.03 DEFINITIONS

- A. Conditioned Space: An area inside the building which is heated and/or cooled.
- B. Tempered Space: an area inside the building which is not directly heated or cooled, but is adjacent to a heated or cooled space with no insulation separating the two spaces (e.g., ceiling plenums).
- C. Untempered Space: an area inside the building which is not conditioned and is not tempered (e.g., attic spaces).
- D. Exterior: An area outside the building (e.g., roof mounted items).

1.04 QUALITY ASSURANCE

- A. Duct and plenum construction, metal gauges, reinforcing, methods of supporting and hanging and other sheet metal work as called for shall be in accordance with the following standards:
 - 1. "SMACNA HVAC Duct Construction Standards", most recent Edition, by the Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
- B. Unless noted otherwise, all ductwork shall be provided with pressure class and leakage class as indicated and scheduled on the plans. If pressure or seal class is not indicated, ductwork shall be provided to meet the pressure class based on the scheduled capacity of the equipment it is served by or connected to and with seal class A.
- C. NFPA Compliance: All liner and covering materials shall have maximum UL Flame Spread Index of 25, and maximum Smoke Developed Index of 50, and shall meet all requirements of NFPA 90A.

1.05 SUBMITTALS

- A. Shop Drawings:
 - 1. Submit $\frac{1}{4}$ " per foot scale shop fabrication shop drawings.
 - a. Shop drawings shall include locations of all control devices, including dampers, airflow measuring stations, sensors, etc. Coordinate locations with the BAS Contractor prior to submitting shop drawings. Shop drawings shall include the BAS Contractor's submittal review stamp prior to submitting to the Design Professional for review.

2. Submit shop drawings of elbows and fittings showing static pressure loss charted for air quantities involved in each.
- B. Product Data: Submit manufacturer's specifications and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, thickness, and furnished accessories for each mechanical system requiring insulation. Submit product data for each accessory/component for ducts/fittings including, but not limited to turning vanes, tie rods, sealants and balancing dampers.
- C. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data in maintenance manual.
- D. Certifications: Submit certifications or other data as necessary to show compliance with these specifications and governing regulations. Include proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.

1.06 REGULATORY REQUIREMENTS

- A. National Fire Protection Association, NFPA 90A: Air Conditioning and Ventilating Systems.
- B. Underwriter's Laboratories, UL 181: Factory-Made Duct Materials and Air Duct Connections.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Protect shop-fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling.
 1. Stored materials subject to rejection due to damage.
- B. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard ratings of products.
- C. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged insulation; remove from project site.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. All sheet metal work shall be constructed of prime quality re-squared tight coat galvanized steel, except where other type material is specified. Manufacturer's name and U.S. gauge number shall appear on each sheet.
- B. Duct Lining Materials
 1. Certain Teed
 2. Owens Corning Fiberglass
 3. Johns Manville
 4. PPG
 5. Knauf
 6. Armacell

2.02 LOW VELOCITY DUCTWORK

- A. General: Provide factory fabricated or shop fabricated duct and fittings.
- B. Materials:
 1. Galvanized sheet steel complying with ANSI/ASTM A527, lockforming quality, with ANSI/ASTM A525, G90 zinc coatings, mill phosphatized.
 2. Aluminum sheet complying with ASTM B 209 Alloy 3003, H14 temper with mill finish. Where ductwork is exposed and not designated to be painted, provide one-side bright finish.
- C. Gauge: Comply with code requirements for minimum gauge thickness for various sizes.
- D. Fittings:
 1. Construct branches, bends, and elbows with centerline radius of not less than duct 1.0 times the width (diameter), where space conditions will not permit this radius or where indicated on drawings, square elbows with air turns shall be used.

2. Slopes for transitions or other changes in dimension shall be minimum 1:3.
3. Longitudinal seams shall be Pittsburgh Lock or snaplock equal per SMACNA. Lateral seams shall be slip drive or standing. Slip seams and sheet metal screws not permitted.

2.03 GALVANIZED STEEL DUCTWORK – HIGH VELOCITY

- A. Single-Wall Ducts: Spiral-wound, zinc-coated steel with individual formed steel tees and elbows.

1. Single-Wall Round Duct Gauges:

<u>Minimum USS Gauge Duct Diameter (Inches)</u>	<u>Spiral Lock Seam</u>
Up to 8	26
9 to 22	24
23 to 36	22
37 to 50	20
51 to 60	18
61 and Over	16

2. Single-Wall Oval Duct Gauges, Factory-Made with Spiral Lock Seams:

<u>Minimum USS Gauge Duct Diameter (Inches)</u>	<u>Minimum USS Gauge</u>	<u>Spiral Lock Seam</u>
Up to 10	24	None
11 to 20	22	4 foot centers
21 to 40	18	2 x 2 x 1/8 angle 2.5 foot centers
41 to 72	16	2 x 2 x 3/16 angle 2 foot centers

- B. Access Panels: Shall be of same material as ducts in which they are installed, fabricated of two thicknesses of not less than 24 gauge, with 1" thick rigid glass fiber filler. Provide sheet metal frame, air tight gasket equal to United McGill AOBXFDDC.

- C. Fabrication

1. Directional Change:
 - a. Construct tees, bends, and elbows with radius minimum 1.0 times width of duct on center line.
2. Size Change:
 - a. Increase and decrease duct sizes gradually, not exceeding 15%, unless otherwise noted on Drawings.
3. Seams and Joints: In accordance with SMACNA standards.
 - a. Rigidly construct metal ducts with joints mechanically tight, substantially airtight, braced and stiffened so not to breathe, rattle, vibrate or sag.
 - b. Where spiral ductwork is exposed, assemble duct to duct joints with spiral seam following continuous helicoid pattern across joints.

2.04 PLENUMS

- A. Plenums shall be fabricated of same material as duct connecting to plenum; shall be two metal gauges heavier than gauge of largest duct connecting to plenum.

2.05 LAUNDRY VENT DUCTS

- A. General:

1. Fabricate laundry vent ducts and supports, used for venting of commercial or residential laundry dryers, of 22 gauge minimum aluminum. The male end of the duct at overlapped duct joints shall extend in the direction of airflow. Sheetmetal screws used for connecting sections of laundry vent may not extend more than 1/8" into the duct.
2. Each vertical laundry vent riser shall be provided with a means of cleanout at the base.
3. Duct shall terminate outside the building as shown on drawings. A backdraft damper shall be installed at the termination. No bird or insect screens shall be installed at the termination point.

2.06 DUCT SEALING – LOW VELOCITY

- A. All joints in low velocity duct work shall be sealed with Foster 32 14 or DuctMate ProSeal. Apply and install joint sealer per manufacturer's recommendations. In general, apply to male end of coupling and/or interior of female fitting. After connection, brush sealant over the assembled joint and screws with a 2" to 3" wide band. Sealant shall be allowed to set for 48 hours before any air pressure is put on system. All tie bars, bolts and rivets shall be sealed with the specified sealant. Sealant as manufactured by 3M No. 800 or United Sheet Metal will be considered equal.
- B. Alternate Sealing System:
 - 1. Transverse duct joints may be made with the Ductmate System or an approved equal.
 - 2. The installation of the Ductmate System shall be in accordance with the manufacturer's printed instruction and installation manuals.
 - 3. The standard Ductmate System joint is the equivalent of a SMACNA "J" connection. The Ductmate JR System joint is the equivalent of a SMACNA "E" connection. Construction of the duct, such as gauge, reinforcing, etc. shall be as indicated in the addendum to the SMACNA manuals as provided by the manufacturer and as tested by Pittsburgh Testing Laboratory.
- C. Duct Sealing Requirements: SMACNA Seal Class A.

2.07 DUCT SEALING - HIGH VELOCITY

- A. All joints in high velocity duct work shall be sealed with Foster 32 14 or Ductmate ProSeal. Apply and install joint sealer per manufacturer's recommendations. In general, apply to male end of coupling and/or interior of female fitting. After connection, brush sealant over the assembled joint and screws with a 2" to 3" wide band. Sealant shall be allowed to set for 48 hours before any air pressure is put on system. All tie bars, bolts and rivets shall be sealed with the specified sealant. Sealant as manufactured by Minnesota Mining No. 800 or United Sheet Metal will be considered equal.
- B. Alternate Sealing System:
 - 1. Transverse duct joints may be made with the Ductmate System or an approved equal.
 - 2. The installation of the Ductmate System shall be in accordance with the manufacturer's printed instruction and installation manuals.
 - 3. The standard Ductmate System joint is the equivalent of a SMACNA "J" connection. The Ductmate JR System joint is the equivalent of a SMACNA "E" connection. Construction of the duct, such as gauge, reinforcing, etc. shall be as indicated in the addendum to the SMACNA manuals as provided by the manufacturer and as tested by Pittsburgh Testing Laboratory.
- C. Duct Sealing Requirements: SMACNA Seal Class A.

2.08 DUCT LINER

- A. Lining materials shall be Type 'A' Duct Liner, Certain Teed Toughgard or equivalent, one and one half (1 1/2) pounds per cubic foot density or equal.
- B. Unless specifically indicated to not be insulated, all ductwork and accessories shall be either lined or wrapped. Duct systems not listed or without a type or thickness indicated on the plans shall be insulated with 1-1/2" wrap.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Assemble and install ductwork in accordance with recognized industry practices which will achieve airtight and quiet systems, capable of performing each indicated service.
 - 1. Install each run with minimum joints.
 - 2. Align ductwork accurately at connections and with internal surfaces smooth.
 - 3. Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts true-to-shape and prevent buckling and vibration.

- B. Ducts shall be installed following essentially lines indicated on drawings, install offsets, angles and transitions as may be required to avoid interferences with other work. Maintain full capacity of ducts at offsets, angles and transitions except where drawings indicate use of reducing or increasing transitions.
 - 1. General: Each duct section shall be rigidly supported from structure. Attach hangers to structure with expansion plugs, concrete inserts, beam clamps or other approved means. Rubber in shear isolators shall be installed in hangers for all ducts in equipment rooms, to prevent vibration transmission to the structure.
- C. Install hangers and supports in accordance with SMACNA Standards general locations:
 - 1. Install hangers close to transverse joints of main ducts and branches, clinch collar branch connections and the first branch elbows after nested splits.
 - 2. Locate hangers of duct penetrating walls or partitions as though the walls will contribute no support to the duct.
 - 3. Install hangers in pairs on exact opposite sides of duct.
 - 4. Maintain hanger spacing intervals less than, equal to, but not greater than the specified maximums.
 - 5. Install hangers at the midpoint of small and medium size horizontal vaned square elbows. On wide vaned square elbows, install additional hangers at maximum allowable intervals or less measured along the heel lines of the elbows.
 - 6. Provide a set of hangers at the midpoint of small and medium size horizontal radius elbows. Install one or more supplementary hangers, as necessary, along the inside and outside arcs of large radius elbows of any angle whenever the lengths of these arcs exceed the maximum hanger spacing length for that particular size duct.
 - 7. Provide at least one set of hangers for short duct branches 3 feet or less in length.
 - 8. Provide each duct riser with a minimum of two supports completely spanning the shaft opening at each floor. One pair of supports may be used to support more than one duct riser, provided that the strength of the supports is increased appropriately and proper additional supplementary steel is used at the extra risers.
 - 9. Support duct risers, located between floors that are more than 15 feet high, at each floor and halfway points between floors. The distance between intermediate supports on very high floors should not exceed 12 feet. Intermediate hangers may be supported from an adjacent wall or hung by rods from supports on the floor above.
 - 10. Provide one or more sets of hangers for equipment in duct runs such as heating coils, heat pumps, etc., as recommended by their manufacturers.
 - 11. Hangers shall not be attached to metal roof deck.
- D. Locate duct hangers approximately:
 - 1. 2 to 24 inches from flexible connections of fans.
 - 2. 2 to 24 inches from the outlets or flexible connects of VAV control units or mixing boxes.
 - 3. 12 to 36 inches from the main duct to the first hanger of long branch ducts.
 - 4. 2 to 12 inches from the ends of all branch ducts and linear diffuser plenums.
 - 5. 2 to 24 inches from fire damper breakaway joints.
 - 6. 0 inches to half the duct width plus 2 inches from the vertical centerline of the lower elbow of short vertical offsets made with vaned square elbows. The width refers to the dimension of the elbow in the plane of the turn.
 - 7. 0 inches to half the duct width plus 2 inches from the vertical centerline of the bottom and top elbows of vaned square elbow offsets over 8 feet high.
 - 8. One eighth of the arc in from the ends of bottom and top radius elbows of vertical offsets longer than 8 feet. Short vertical offsets require hangers at the bottom elbow. Likewise, sloping offsets need at least one set of hangers at their lower radius elbow.
 - 9. 6 to 12 inches from transverse joints of ducts whose lengths are the same as specified hanger intervals.
 - 10. 6 to 12 inches from one side of walls or partitions penetrated by ducts.

- E. Maximum permitted hanger spacing:
 - 1. Ducts with areas up to 4 square feet may have their hangers spaced up to 8 feet apart.
 - 2. Ducts with areas 4.1 to 10 square feet may have their hangers spaced not more than 6 feet apart.
 - 3. Ducts with areas over 10 square feet may have their hangers located up to 4 feet apart.
- F. Provide and install locking manual volume dampers in all duct systems as required for controlling air volumes to trunk ducts, branch ducts, outlets and inlets. Provide and install additional volume dampers as required by Testing and Balancing Contractor for balancing of system.
- G. All connections shall be sealed, including but not limited to branch connections, spin-ins, taps, access doors, access panels and connections to equipment. Openings for rotating shafts shall be sealed with bushings or other devices that seal off air leakage.
- H. Duct sizes shown on drawings are net inside dimensions and sheet metal size shall be increased to allow for duct linings.
- I. Install as indicated on the drawings all duct mounted equipment as specified in other sections.
- J. Install eccentric reducers with tops of both duct sizes flush to maintain maximum ceiling space below ducts.
- K. Openings:
 - 1. Provide in ductwork to accommodate access doors, temperature control components and fire dampers.
 - 2. Install access panels for inspection and servicing of all duct mounted equipment including, but not limited to: reheat coils, sound attenuators, motorized dampers, airflow measuring stations, smoke and fire dampers.
 - 3. Provide pitot tube openings for testing of systems, complete with metal cap, with spring device or screw to ensure against air leakage.
 - 4. Where openings are provided in insulated ductwork, install insulation materials inside metal collar.
- L. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- M. Connections:
 - 1. Connect duct to equipment with flexible fabric, sheet metal clips, screws and washers.
 - 2. At each point where ducts pass through partitions, provide sleeve with space between duct and sleeve packed with insulation and sealed.
- N. Where ducts pass through fire-rated walls, partitions, floors, and ceilings, seal openings in accordance with Specification Section 23 05 00 - Common Work Results for HVAC.

3.02 DUCT LINER APPLICATION

- A. Apply duct liner with coated or surface designed to be exposed facing the air stream and adhered with 100% coverage of fire retardant adhesive. When width exceeds 12" or height exceeds 24", additionally secure liner with mechanical fasteners spaced 12" maximum centers. Fasteners shall start within 3" of leading edge of traverse joints. Coat all exposed joints and edges of traverse joints with a fire retardant adhesive.
- B. Duct sizes shown on drawings are net inside dimensions and sheet metal size shall be increased to allow for duct lining.

3.03 ADJUSTING AND CLEANING

- A. Cleaning:
 - 1. Clean ductwork internally, as it is installed, of dust and debris.
 - 2. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or where ductwork is to be painted.

B. Temporary Closure:

1. At ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation or that are on-site but not yet installed, provide temporary closure of polyethylene film or other covering until time connections are to be completed.

3.04 DUCTWORK APPLICATION SCHEDULE – LOW VELOCITY

<u>AIR SYSTEM</u>	<u>MATERIAL</u>
HVAC Supply, Return General Exhaust Transfer	Steel, Galvanized
Clothes Dryer Exhaust	Aluminum

3.05 DUCTWORK APPLICATION SCHEDULE – HIGH VELOCITY

<u>AIR SYSTEM</u>	<u>MATERIAL</u>
HVAC Supply, Return, and General Exhaust	Steel, Galvanized

END OF SECTION 23 31 13

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SECTION 23 33 00
AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.01 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this Section.

1.02 DESCRIPTION OF WORK

- A. Extent of duct accessories is indicated on drawings and by the requirements of this section.
- B. Types of duct accessories required for project include the following:
 - 1. Fire and Smoke Dampers
 - 2. Volume Dampers/Regulators
 - 3. Flexible Ducts
 - 4. Access Doors

1.03 QUALITY ASSURANCE

- A. SMACNA Compliance: Comply with applicable portions of Sheet Metal and Air Conditioning Contractor's National Association (SMACNA) "Fire Damper and Heat Stop Guide".
- B. Industry Standards: Comply with American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE) recommendations pertaining to construction of duct accessories, except as otherwise indicated.
- C. UL Compliance: Construct, test, and label fire dampers in accordance with Underwriters Laboratories (UL) Standard 555 "Fire Dampers and Ceiling Dampers".
- D. NFPA Compliance: Comply with applicable provisions of ANSI/NFPA 90A "Air Conditioning and Ventilating Systems", pertaining to installation of duct accessories.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's technical information for each type of duct accessory, including dimensions, capacities, materials of construction, installation instructions, interfacing requirements with ductwork, and method of fastening or support where applicable.
- B. Maintenance Data: Submit manufacturer's maintenance data including parts lists for each type of duct accessory; include this data in Maintenance Manual.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, provide products manufactured by one of the following:
 - 1. Flexible Ductwork
 - a. Semco
 - b. Wiremold
 - c. Thermaflex
 - d. Valuflex
 - 2. Flexible Ductwork – High Velocity
 - a. Flexmaster: Type 3
 - b. Genflex: IHPL (1-1/2" thick insulation)
 - c. Thermaflex: M-KC (1-1/2" thick insulation)
 - 3. Fire Dampers and Smoke Dampers
 - a. Air Balance, Inc.
 - b. Pottorff
 - c. Ruskin Manufacturing Co.
 - d. Leader Industries
 - e. Greenheck

- f. Safe-air / Dowco
- g. Louvers & Dampers
- h. United Enertech
- i. Anemostat

2.02 FIRE AND SMOKE DAMPERS

A. General

- 1. Refer to 23 31 13 Metal Ducts for Low Velocity and High Velocity ductwork classifications.
- 2. In general, fire dampers, smoke dampers, and combination fire/smoke dampers are to consist of galvanized steel frame and blade construction, 165 degrees F. release temperature, and 1.5 hour UL 555 rating. Any locations requiring stainless steel construction, 212 degree F release temperature, or 3 hour UL 555 rating are identified on the drawings.

B. Fire Dampers

- 1. Low Velocity Ductwork: Curtain type or low profile, single blade style dynamic fire dampers shall have a fire rating of 1.5 hours. Damper frame and blades shall be galvanized steel in gauges required by UL listing R-5531. Provide fusible link rated at 165 degrees F; link shall be labeled for use in dynamic systems. Dampers shall be rated for dynamic closure up to 2,000 fpm and 4" wg.
 - a. Curtain type duct mounted fire dampers to be Style B for rectangular ductwork and Style CR/CO for round and oval ductwork such that damper curtain is located outside of airstream. Closure spring dampers shall be stainless steel and shall be constant force type. Ruskin DIBD2 or equal.
 - b. Single blade style duct mounted fire dampers to have stainless steel bearings, permanently lubricated sleeve type turning in an extruded hole in the frame. Ruskin DFD-LP or equal.
 - c. Round fire damper to be Ruskin FDR25 or equal, 20 gage galvanized steel frame/sleeve with single skin 14 gage blades and stainless steel sleeve bearings.
 - d. Where 3-hour rated walls are indicated, fire damper shall be 3 hour UL555 Rated (Ruskin DIBD23 or equal).
- 2. Low Velocity Ductwork: Multiple blade dynamic fire dampers shall have a fire rating of 1.5 hours. Damper frame shall be constructed of 16 gage galvanized steel and damper blades shall be single skin 16 gage thickness. Bearings shall be stainless steel, permanently lubricated sleeve type turning in an extruded hole in the frame. Provide fusible link rated at 165 degrees F. Dampers shall be approved for vertical or horizontal mounting and shall be labeled for use in dynamic systems up to 2,000 fpm and 4" w.g. Ruskin DFD35 or equal
 - a. Where 3-hour rated walls are indicated, fire damper shall be 3 hour UL555 Rated (Ruskin DFD60-3 or equal).
- 3. High Velocity Ductwork: Multiple blade dynamic fire dampers shall have a fire rating of 1.5 hours. Damper frame shall be constructed of 16 gage galvanized steel and damper blades shall be single piece airfoil shaped with 14 gage equivalent thickness. Bearings shall be stainless steel, permanently lubricated sleeve type turning in an extruded hole in the frame. Provide fusible link rated at 165 degrees F. Dampers shall be approved for vertical or horizontal mounting and shall be labeled for use in dynamic systems up to 4,000 fpm and 4" w.g. Ruskin DFD60 or equal.
 - a. Where 3-hour rated walls are indicated, fire damper shall be 3 hour UL555 Rated (Ruskin DFD60-3 or equal).

C. Smoke Dampers

- 1. Frame shall be a minimum of 16 gage galvanized steel formed into a structural hat channel shape with tabbed corners for reinforcement. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame. Blade edge seals shall be silicone rubber mechanically locked to blade. Jamb seal shall be stainless steel flexible metal compression type.
 - a. For low velocity ductwork, blades to be v-grooved type, 16 gage minimum galvanized steel. Basis of Design: Ruskin SSD 36.

- b. For high velocity ductwork, blades to be airfoil type, 14 gage minimum galvanized steel. Basis of Design: Ruskin SD 60.
- 2. Each smoke damper shall be classified by Underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems under the latest version of UL555S and bear a UL label attesting to same. Damper manufacturer shall have tested, and qualified with UL, a complete range of damper sizes covering all dampers required by this specification. Testing and UL qualifying a single damper size is not acceptable.
 - a. For low velocity ductwork, leakage rating under UL 555S shall be leakage Class II. As part of the UL qualification, dampers shall have demonstrated a capacity to operation (to open and close) under HVAC system operating conditions, with pressures of at least 4" w.g. in the closed position and 2,000 FPM air velocity in the open position.
 - b. For high velocity ductwork, leakage rating under UL 555S shall be leakage Class I. As part of the UL qualification, dampers shall have demonstrated a capacity to operation (to open and close) under HVAC system operating conditions, with pressures of at least 8" w.g. in the closed position and 4,000 FPM air velocity in the open position.
 - c. Where 3-hour rated walls are indicated, combination fire/smoke damper shall be 3 hour UL555 Rated, UL555S Leakage Class I (Ruskin SD60-3 or equal).
- 3. In addition to the leakage ratings already specified herein, the dampers and their actuators shall be qualified under UL555S to an elevated temperature of 250 deg. F or 350 deg. F, depending upon the actuator. Electric actuators (120V two position) shall be installed by the damper manufacturer at time of damper fabrication. Damper and actuator shall be supplied as a single entity which meets all applicable UL555S qualifications for both dampers and actuators. Factory supplied caulked sleeve shall be 20 gage for dampers through 84" wide and 18 gage above 84" wide. Damper and actuator assembly shall be factory cycled 10 times to assure operation. All wiring or piping material required to interconnect the actuator with detection and/or alarm or other systems shall be provided by Division 28.
- 4. Blade position Indicator: Each smoke damper shall be equipped with Ruskin SP100 Switch Package or equal.
 - a. The Switch Package shall include two position indicator switches linked directly to the damper blade to provide the capability of remotely indicating damper blade position.
- D. Combination Fire/Smoke Dampers
 - 1. Frame shall be a minimum of 16 gage galvanized steel formed into a structural hat channel reinforced at corners. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame. Galvanized bearings are not acceptable. Blade edge seals shall be silicone rubber and galvanized steel mechanically locked into blade edge (adhesive or clip fastened seals not acceptable). Jamb seals shall be non-corrosive stainless steel flexible metal compression type to further ensure smoke management.
 - a. For low velocity ductwork, blades to be v-grooved type, 16 gage minimum galvanized steel. Basis of Design: Ruskin FSD 36.
 - b. For high velocity ductwork, blades to be airfoil type, 14 gage minimum galvanized steel. Basis of Design: Ruskin FSD 60.
 - 2. Unless specifically noted otherwise, each combination fire/smoke damper shall be classified for use for fire resistance ratings of less than 3 hours, in accordance with UL standard 555, and shall further be classified by Underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems in accordance with the latest version of UL555S, and bear a UL label attesting to same. Damper manufacturer shall have tested, and qualified with UL, a complete range of damper sizes covering all dampers, required by this specification. Testing and UL qualifying a single damper size is not acceptable.
 - a. For low velocity ductwork, leakage rating under UL 555S shall be leakage Class II. As part of the UL qualification, dampers shall have demonstrated a capacity to operation (to open and close) under HVAC system operating conditions, with pressures of at least 4" w.g. in the closed position and 2,000 FPM air velocity in the open position.

- b. For high velocity ductwork, leakage rating under UL 555S shall be leakage Class I. As part of the UL qualification, dampers shall have demonstrated a capacity to operation (to open and close) under HVAC system operating conditions, with pressures of at least 8" w.g. in the closed position and 4,000 FPM air velocity in the open position.
- c. Where 3-hour rated walls are indicated, combination fire/smoke damper shall be 3 hour UL555 Rated, UL555S Leakage Class I (Ruskin FSD60-3 or equal).
- 3. In addition to the leakage ratings already specified herein, the dampers and their actuators shall be qualified under UL555S to an elevated temperature of 350 deg. F. Appropriate 120V electric actuators shall be installed by the damper manufacturer at time of damper fabrication. Damper and actuator shall be supplied as a single entity which meets all applicable UL555 and UL555S qualifications for both dampers and actuators. Manufacturer shall provide factory assembled sleeve of 17" minimum length (contractor to verify requirement). Factory supplied caulked sleeve shall be 20 gage for dampers through 84" wide and 18 gage above 84" wide. Damper and actuator assembly shall be factory cycled 10 times to assure operation. All wiring or piping material required to interconnect the actuator with detection and/or alarm or other systems shall be provided by Division 28.
- 4. Each combination fire/smoke damper shall become equipped with a controlled 7 to 15 second heat-actuated release device. The device shall close and lock the fire/smoke damper during test, smoke detection, power failure or fire conditions through actuator closure springs. To prevent duct and HVAC component damage, the damper shall at all times be connected to the actuator for controlled closure in not less than 7 seconds and no more than 15 seconds. Instantaneous damper closure is unacceptable. Damper shall be automatic resettable after test, smoke detection or power failure conditions. After exposure to high temperature or fire, the damper must be inspected prior to reset to ensure proper operation. Release temperatures are 165 deg. F.
- 5. Blade Position Indicator: Each damper shall be equipped with Ruskin SP100 Switch Package or equal.
 - a. The Switch Package shall include two position indicator switches linked directly to the damper blade to provide the capability of remotely indicating damper blade position.

2.03 MISCELLANEOUS

- A. Manual Volume Dampers:
 - 1. Rectangular duct width of 48" or smaller and height of 12" or smaller or all round ducts.
 - a. Damper shall be fabricated of same material as the duct, two metal gauges heavier than duct and hammered 1" all around.
 - b. Provide end bearings with gasket. Models listed are Young Regulator Co. Equals by Elgin are acceptable
 - 1) Round ducts 4" to 8" with 3/8" rod: Model 666-RD.
 - 2) Round ducts greater than 8" and all rectangular ducts with 3/8" rod: Model 666-FD.
 - 3) All round and rectangular ducts with 1/2" rod: Model 515A.
 - c. Blades and rods construction:
 - 1) Rectangular duct width of 12" or smaller: Damper blade shall be mounted on two 3/8" pins on the ends of the blade.
 - 2) Rectangular duct width greater than 12": Damper blade shall be mounted on continuous 1/2" rod.
 - 3) Round duct of 12" diameter or smaller: Damper blade shall be mounted on two 3/8" pins on the ends of the blade.
 - 4) Round duct diameters larger than 12": Damper blade shall be mounted on a continuous 1/2" rod.
 - 2. All other rectangular duct that fall outside the criteria above shall be opposed action multi-blade.
 - a. Damper frames are to be constructed of minimum 13-gauge.
 - b. Damper blade width shall not exceed 9 inches and the blade length shall not exceed 48 inches. Damper blades shall be of corrugated type construction.

- c. Damper shall be constructed of the same material as the duct in which it will be installed.
 - d. Where damper shafts penetrate the damper housing, it shall be sealed while allowing the free movement of the shaft without breaking the seal.
 - e. Provide with shaft extension where duct will have exterior insulation applied.
- B. Manual Volume Damper Regulators:**
- 1. Accessible areas: Provide locking position regulator with gasket and handle. Below model numbers are based on Young Regulator Co. Equals by Elgin are acceptable.
 - a. Model 403 for a 3/8" damper shaft on ductwork without external insulation.
 - b. Model 443B for a 3/8" damper shaft on ductwork with external insulation.
 - c. Model 404 for a 1/2" damper shaft on ductwork without external insulation.
 - d. Model 404B for a 1/2" damper shaft on ductwork with external insulation.
 - 2. Inaccessible areas: Provide concealed manual volume damper regulators with BCW casing and wire and rack and pinion assembly. Damper shall be able to be operated when the damper and rack and pinion assembly are up to 50 ft apart. Young Regulator Co. Model 270-275 or equal by Elgin. Provide minimum 6" tag for each damper for identification.
- C. Backdraft Dampers**
- 1. Counter-balanced backdraft damper Ruskin model CBD6 or equal.
 - a. Frame: Heavy duty 0.125" thick aluminum
 - b. Blades: 0.070 thick aluminum with extruded vinyl edge seals
 - c. Bearings: Zytel
 - d. Linkage: 0.125" thick aluminum tie bars
 - e. Counterbalance: Zinc plated bar mounted on blades with adjustability for job site final setting
 - f. Temperature: -40 deg F to 200 deg F
 - g. Back Pressure:
 - 1) 48" section width – up to 4" wc
 - 2) 36" section width – up to 8" wc
 - 3) 24" section width – up to 12" wc
 - 4) 12" section width – up to 16" wc
 - h. Operation: blades start to open at 0.01" wc and are fully open at 0.05" wc
- D. Air Turns:** Elgen "Air Tite" or equal shop fabricated.
- E. Flexible Duct Connection:**
- 1. Ventfabrics, Inc. Ventglas or equal.
 - 2. Flexible neoprene or heavy glass fabric duct connector with minimum material thickness of 0.024" and weight of 30 oz/sq. yard.
 - 3. Minimum temperature range shall be 30 to 200 deg F.
 - 4. The materials shall have a flame spread rating below 25 and smoke development rating below 50.
 - 5. The minimum static pressure rating shall be 10".
- F. Access Panels:** Shall be of same material as ducts in which they are installed, fabricated of two thicknesses of not less than 24 gauge, with 1" thick rigid glass fiber filler. Provide sheet metal frame, air tight gasket and two thumb operated cam lock latches. Latches must be operable without the use of any tools.

2.04 FLEXIBLE DUCT – LOW VELOCITY

- A. Flexible duct shall be factory pre-insulated, consisting of vinyl coated spring steel wire helix bonded to vinyl coated fiberglass mesh screen, having one (1) inch nominal fiberglass insulation and vinyl impregnated closely woven fiberglass vapor barrier. Basis of Design: Semco, Type A1.
- B. Composite assembly shall meet Class I requirements of NFPA-90A and shall be UL listed for flame spread rating of not more than 25 and smoke developed rating of not more than 50. Assembly shall meet the requirements of UL-181.

- C. Where flexible duct is allowed, it shall be connected to metal ducts, terminal units and diffusers with Panduit, Tylon or equal tool installed nylon clamps.
- D. Maximum length of flexible duct connections from metal duct to terminal units and grilles, registers and diffusers shall be not greater than 72". All duct turns greater than 45 deg. shall be rigid elbows.
- E. Wherever ductwork is routed exposed, flexible ductwork is not acceptable. All exposed ductwork to be rigid.

2.05 FLEXIBLE DUCT – HIGH VELOCITY

- A. Suitable for -20°F to 220°F temperature range and minimum 12 inches w.c. working pressure.
- B. Inner Liner: Glass fiber, PVC coating, factory-clinched in cold-rolled galvanized steel spiral, or with spiral wire permanently bonded to fabric, UL listed, complying with NFPA 90.
- C. Outer Jacket: 1-1/2" thick, 3/4 lb. fibrous glass, with flame-resistant PVC vapor barrier.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which duct accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install duct accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.
- B. Install access panels for inspection and servicing of all duct mounted equipment including, but not limited to: reheat coils, sound attenuators, motorized dampers, airflow measuring stations, fire dampers, smoke dampers, and combination fire/smoke dampers. Unless noted otherwise, access doors to be square and dimensions shall be 2" less than the duct dimension where they are installed, with a maximum size requirement of 24" x 24". Locate access doors (i.e. side or bottom of duct) where they provide the best access to duct equipment/accessory relative to surrounding piping, equipment, structure, etc.
- C. Access doors for fire dampers, smoke dampers, and combination fire/smoke dampers shall be a minimum of 12" x 12". Where maximum duct dimension (height or width) is less than 12", provide a square access door with dimensions 2" less than the duct dimension where door is installed; also, a removable section of ductwork shall be provided at the damper connection to allow for access to the damper. Removable section of ductwork shall be 24" in length and have flanged connections on both ends (or may be an elbow fitting if immediately downstream of damper).
- D. Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.
- E. Install all fire, smoke, and combination fire/smoke dampers in accordance with manufacturer's installation instructions for UL Listing.
- F. Coordinate with other work, including ductwork, as necessary to interface installation of duct accessories properly with other work.
- G. Field Quality Control: Operate installed duct accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leakproof performance.
- H. Coordinate installation of smoke and combination fire/smoke damper switch package and indicating lights with Electrical Contractor. Switch package to be provided by HVAC Contractor.
- I. Furnish General Contractor with layout and size of wall openings. Coordinate installation of louver with General Contractor. Make duct connections to louvers as shown on the plans.
- J. Install all manual dampers with damper in full open position.

END OF SECTION 23 33 00

SECTION 23 34 16
HVAC FANS

PART 1 - GENERAL

1.01 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this Section.

1.02 DESCRIPTION OF WORK

- A. Extent of HVAC fan work is indicated on drawings and schedules, and by requirements of this section.
- B. Types of fans required for this project include the following:
 - 1. In-line Cabinet Fans
 - 2. Power Ventilators
- C. Refer to section 23 05 13 Common Motor Requirements for HVAC Equipment for motor requirements furnished with HVAC fans.
- D. Refer to Division 26 sections for power work required in conjunction with air distribution equipment; not work of this section.

1.03 QUALITY ASSURANCE

- A. AMCA Compliance: Provide HVAC fans bearing the Air Movement and Control Association, Inc. (AMCA) Certified Ratings Seal.
- B. UL Compliance: Provide air distribution equipment electrical components which have been listed and labeled by Underwriters Laboratories (UL).
- C. NFPA Compliance: Fan and fan installation shall be compliant with applicable NFPA requirements.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver HVAC fans with factory installed shipping skids and lifting lugs; pack components in factory fabricated protective containers.
- B. Handle HVAC fans carefully to avoid damage to components, enclosures, and finish. Do not install damaged components; replace and return damaged components to fan manufacturer.
- C. Store HVAC fans in clean dry place and protect from weather and construction traffic.

1.05 SUBMITTALS

- A. Submittal data shall include physical dimensions, fabrication details, materials, fan curves, sound ratings, motor size and electrical characteristics and required brake horsepower for specified operating conditions.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. In-line Cabinet Fans
 - 1. Greenheck
 - 2. Carnes
 - 3. PennBarry
 - 4. Loren Cook Co.
 - 5. Twin City Fan & Blower
 - 6. Acme
 - 7. Thernotek
- B. Power Ventilators
 - 1. Greenheck
 - 2. Carnes

3. PennBarry
4. Loren Cook Co.
5. Twin City Fan and Blower
6. Acme
7. Thermotek

2.02 IN-LINE CABINET FANS

- A. General: Provide duct mounted supply, exhaust or return fans of the centrifugal, belt driven in-line type.
- B. Ratings: All fans shall bear the AMCA Certified Ratings Seal for air performance.
- C. Casing: The fan housing shall be of the rectangular design constructed of heavy gauge galvanized steel and shall include rectangular duct mounting collars. A hinged or removable panel shall be provided in the fan cabinet of sufficient size to permit access for service to all of the fan's internal components without dismantling the cabinet.
- D. Fan: The fan wheel shall be of the galvanized steel, forward curved, centrifugal type. Wheels shall be dynamically and statically balanced.
- E. Motor: Heavy duty type with permanently sealed ball bearings. The wheel shaft shall be ground and polished steel mounted in permanently sealed pillow block bearings.
- F. Drives: For belt drive units a drive shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the machined cast iron type, keyed and securely attached to the wheel and motor shafts. The motor pulleys shall be adjustable for final system balancing.
- G. Accessories:
 1. Insulated Housing
 2. Disconnect switches
 3. Spring Vibration Isolators

2.03 POWER VENTILATORS

- A. Fans shall be complete factory assembled units and shall include housings, non overloading fan wheels, adjustable speed V belt drives, air stream cooled motors and vibration isolators.
- B. Fan wheel classification must be capable of maximum rpm achievable based on the motor horsepower provided.
- C. Housings shall be of aluminum.
- D. A conduit chase shall be provided for running the electrical wiring through the curb into the motor compartment.
- E. Single phase motors shall be furnished with built in overload protection.
- F. Each unit shall be equipped with the following accessories:
 1. Expanded aluminum bird screen
 2. Disconnect device
 3. Variable pitch motor pulley
 4. Self-acting backdraft damper
 5. Motorized damper
 6. Factory Insulated Roof curb to match roof pitch.

PART 3 - EXECUTION

3.01 INSPECTIONS

- A. Examine areas and conditions under which fans are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF HVAC FANS

- A. Install fans where indicated, in accordance with equipment manufacturer's installation instructions, and with recognized industry practices, to ensure that equipment complies with requirements and serves intended purposes.

- B. Coordinate with other work, including ductwork and electrical work as necessary to interface installation of HVAC fans with other work. Furnish layout and size of roof curbs for roof mounted fans and wall openings for wall mounted fans to General Contractor.
- C. Install units with vibration isolators or isolation bases, complying with Division 23, Section 23 0548 - Vibration Controls for HVAC Piping, ductwork and Equipment.
- D. Secure curb cap of roof mounted fans to wood nailer on roof curb within 3" of corners and 18" on center with nonferrous, cadmium plated or stainless steel lag screws using weather resistant gaskets to form a watertight connection.
- E. Alignment: Check alignment of belt driven fans, and, where necessary, realign shafts of motors and fans within recommended tolerances by manufacturer, and in presence of manufacturer's service representative

3.03 ELECTRICAL CONNECTIONS

- A. Ensure HVAC fans are wired properly, with rotation in direction indicated and intended for proper performance.
- B. Provide positive electrical equipment and motor grounding.

3.04 FIELD QUALITY CONTROL

- A. Upon completion of installation of HVAC fans, and after motor has been energized with normal power source, test equipment to demonstrate compliance with requirements. Where possible, field correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment which cannot be satisfactorily corrected.

3.05 BALANCING

- A. Refer to Division 23, Section 23 05 93 - Testing, Adjusting and Balancing for HVAC of fan systems; not work of this section.

3.06 SPARE PARTS

- A. General: Furnish to owner, with receipt, 1 spare set of belts for each belt driven equipment item.

END OF SECTION 23 34 16

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**SECTION 23 36 00
AIR TERMINAL UNITS**

PART 1 - GENERAL

1.01 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this Section.

1.02 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary to install air terminal units as required by the drawings and this section.

1.03 TERMINAL UNITS

- A. Air Terminal units shall include the following:
 - 1. VAV Boxes

1.04 SUBMITTALS

- A. Submit shop drawings and/or catalog cuts showing technical data necessary to evaluate the equipment, to include color charts, dimensions, wiring diagrams, performance data and other descriptive data necessary to describe fully the air terminal units.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. VAV Boxes
 - 1. Carnes
 - 2. Titus
 - 3. E.H. Price
 - 4. Metal Aire
 - 5. Krueger
 - 6. Nailor
 - 7. Tuttle & Bailey
 - 8. Johnson Controls

2.02 VAV BOXES

- A. General: Ceiling mounted variable air volume supply air or exhaust control terminals for connection to single, medium pressure duct, central air systems, with heating coils (where scheduled) and air flow measuring station. Direct digital controls and actuation to be provided by DDC Controls Contractor.
- B. Casing: 22-gauge galvanized steel housing, mechanically sealed and gasketed. Provided with round stub inlet duct connection and S and drive outlet duct connection. Hanger holes to be provided on four corners for installation. Leak rate not greater than two percent at 0.5 inch wg. for sizes up through 14 inch and not greater than three percent for sizes 16 inch and above.
- C. Lining: Fiber free foam insulation system which complies with NFPA 90A and UL 181. Fiber free foam insulation thickness to be a minimum of 3/4" (R value = 3).
- D. Control Damper:
 - 1. Locate air volume damper assembly inside unit casing. Construct from extruded aluminum or 20 gauge galvanized steel components with peripheral gasket and solid steel shaft, pivoted in self-lubricating bearings.
 - 2. Air volume control damper shall be factory calibrated assembly consisting of damper and damper shaft extension for connection to externally mounted control actuator.
 - 3. Leakage rate not greater than 2% of nominal CFM at 1" 3 in. w.g. inlet static pressure when tested in accordance with ASHRAE 130.

- E. Air Flow Sensor: Eight point flow sensing ring capable of sensing true airflow to within +/- 10 percent regardless of inlet duct connection. Sensor includes pressure taps on inlet cone of air valve to provide the velocity signal for volume regulator and to measure airflow through the valve when used in conjunction with calibration chart provided on unit.
- F. Automatic Flow Controller: To be a thermostatically reset velocity controller which provides constant delivery air control within +/- 5 percent of rated flow down to 25 percent of unit rated cfm, independent of changes in system static pressure, with 1 1/2 diameters of straight duct at the unit inlet. Control to within +/- 10 percent to be obtained with any inlet duct connection. Factory calibrated, field adjustable setpoints shall be provided to set maximum and minimum cfm.
- G. Reheat Coils (where applicable for supply air units): Electric heating coil shall be factory mounted and heater shall be capable of providing proportional control of reheat capacity using an analog signal (0-10 VDC, 4-20 mA, or PWM) from a room thermostat or from the unit controller. The SCR shall pulse the coil on and off in proportion to the heating demand indicated by the room thermostat/controller. The SCR controller shall provide solid state switching with zero crossover for silent operation. Magnetic or mercury contactors are not acceptable for control of reheat capacity.
- H. Provide terminal unit with control enclosure.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install units and make duct and piping connection as indicated on drawings. Multi-row coils shall be installed in counterflow arrangement relative to airflow.
- B. Install shut off cocks, balancing cocks, air vents, control valves and devices as required for complete installation.
- C. Controls: Install devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Contractor for power wiring.
 - 1. Verify that wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start up until wiring installation is acceptable to equipment installer.
- D. Suspend active chilled beam from the building structure. Attach support to the mounting bracket support points fitted to the lower plate of the primary air plenum.

END OF SECTION 23 36 00

**SECTION 23 37 13
DIFFUSERS, REGISTERS AND GRILLES**

PART 1 - GENERAL

1.01 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary for the installation of grilles, registers and diffusers as per the schedules on the drawings.

1.03 SUBMITTALS

- A. Submit manufacturer's catalog cuts for each type of device to be used.
- B. Product Data: For each product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Acceptable Manufacturers
 - 1. Carnes
 - 2. Titus
 - 3. Price
 - 4. Metal Aire
 - 5. Krueger
 - 6. Nailor

- 2.02 Diffusers, registers, and grilles shall be of the type and style as scheduled.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install wall mounted grilles and registers plumb and level and flush to surface. Locations may be altered slightly, as acceptable to the Design Professional, so as to fit masonry portions of the structure.
- B. In grid panel type ceilings, lay in metal pan, acoustical, etc., grilles, registers and diffusers shall be located in the center of the panel.
- C. Coordinate locations of ceiling diffusers and registers with Design Professional's reflected ceiling plan. Where architectural features or other items conflict with installation, notify Design Professional for determination of final location.
- D. Adjust blow pattern as indicated on plans and as scheduled, prior to balancing.

END OF SECTION 23 37 13

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**SECTION 23 82 39
UNIT HEATERS**

PART 1 - GENERAL

1.01 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary to install unit heaters as required by the drawings and this section.

1.03 UNIT HEATERS

- A. Unit heaters shall include the following:
 - 1. Electric Unit Heaters and Cabinet Unit Heaters

1.04 SUBMITTALS

- A. Submit shop drawings and/or catalog cuts showing technical data necessary to evaluate the equipment, to include color charts, dimensions, wiring diagrams, performance data and other descriptive data necessary to describe fully the terminal units.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Electric Unit Heaters and Cabinet Unit Heaters
 - 1. Trane
 - 2. Brasch
 - 3. Indeeco
 - 4. King Electric
 - 5. Raywall
 - 6. Redd-I
 - 7. Heatrex

2.02 ELECTRIC UNIT HEATERS

- A. Units shall have capacities and ratings and shall be of arrangement as scheduled on the drawings.
- B. Units shall be furnished complete with coils, enclosures, fans and motors as required to make complete functioning units.
- C. Units to be installed in finished areas to be furnished with bonderized, phosphatized, flow coated baked on primer with spray applied baked on enamels in color as selected by Design Professional from the manufacturer's standard offering.
- D. Motors for unit heaters and cabinet unit heaters shall be totally enclosed, Class 'B' insulation, with built in overload protection, and shall be prewired to terminal strip in factory mounted junction box.
- E. Filters for cabinet unit heaters shall have 1" thick woven glass replaceable media, and permanent aluminum frames.
- F. Units shall have single point, line voltage connection for incoming power for 208, 240 or 480 volt services.
- G. Provide the following accessories:
 - 1. Thermostat with external adjustable knob.
 - 2. Three position fan selector switch.
 - 3. Pilot light to indicate when heating elements are energized.
 - 4. Disconnect switch.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install units and make duct and piping connection as indicated on drawings.
- B. Controls: Install devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Contractor for power wiring.
 - 1. Verify that wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start up until wiring installation is acceptable to equipment installer.

END OF SECTION 23 82 39

**SECTION 26 00 10
ELECTRICAL GENERAL PROVISIONS**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 DESCRIPTION OF WORK

- A. Work shall include furnishing of all systems, equipment and material specified in this division and as called for on the electrical drawings, to include supervision, operations, methods and labor for the fabrication, installation, start up and tests for the complete electrical installation.
- B. All elements of the construction shall be performed by workmen skilled in the particular craft involved, and regularly employed in that particular craft.
- C. All work shall be performed in a neat, professional manner in keeping with the highest standards of the craft.

1.03 CODES AND STANDARDS

- A. All work shall be done in accordance with the applicable portion of the following codes and standards:
 - 1. National Electrical Code
 - 2. National Fire Protection Association
 - 3. National Electrical Manufacturers Association
 - 4. Standards of Institute of Electrical and Electronic Engineers
 - 5. International Building Code
 - 6. Occupational Safety and Health Act
 - 7. Iowa Administrative Code
 - 8. NECA Standards
 - 9. Americans With Disabilities Act (ADA)
- B. All Contractors shall familiarize themselves with all codes and standards applicable to their work and shall notify Design Professional of any discrepancies between the design and applicable code requirements so that any conflicts can be resolved. Where two or more codes or standards are in conflict, that requiring the highest order of professionalism shall take precedence, but such questions shall be referred to Design Professional for final decision.

1.04 REQUIREMENTS & FEES OF REGULATORY AGENCIES

- A. Contractor shall comply with the rules and regulations of the local utility companies. He shall check with each utility company providing service to this project and determine or verify their requirements regarding incoming services.
- B. Meters for incoming services shall be selected based on the project requirements. Any questions concerning this shall be referred to Design Professional prior to bidding. Contractor shall provide the appropriate meter and associated materials if not furnished by the utility company.
- C. Secure all required permits and pay for all inspections, licenses and fees required in connection with the electrical work including State of Iowa Electrical Inspections. Contractor shall post all bonds and obtain all licenses required by the State, City, County and Utility.
- D. Contractor shall make all arrangements with each utility company and pay all service charges associated with new service.

1.05 ELECTRICAL DRAWINGS

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

- B. Drawings for the electrical work are in part diagrammatic, and are intended to convey the scope of the work and to indicate in general the location of equipment.
- C. Contractor shall layout their own work and shall be responsible for determining the exact locations for equipment and rough ins and the exact routing of conduits and raceway so as to best fit the layout of the work.
- D. Contractor shall take their own field measurements for verifying locations and dimensions; scaling of the drawings will not be sufficient for laying out the work.
- E. Because of the scale of the drawings, certain basic items such as couplings, pull or splice boxes may not be shown, but where such items are required by code or by other sections of the specifications or where they are required for proper installation of the work, such items shall be furnished and installed.

1.06 ACTIVE SERVICES

- A. Contractor shall be responsible for verifying exact locations of all existing services prior to beginning work in that area.
- B. Existing active services, i.e., water, gas, sewer, electric, when encountered, shall be protected against damage. Do not prevent or disturb operation of active services which are to remain.
- C. When active services are encountered which require relocation, Contractor shall make request to authorities with jurisdiction for determination of procedures.
- D. Where existing services are to be abandoned, they shall be terminated in conformance with requirements of the authorities having jurisdiction.

1.07 SITE INSPECTION

- A. Contractor shall inspect the site prior to submitting bid for work to familiarize themselves with the conditions of the site which will affect their work and shall verify points of connection with utilities, routing of outside conduit to include required clearances from any existing structures, trees or other obstacles.
- B. Extra payment will not be allowed for changes in the work required because of Contractor's failure to make this inspection.

1.08 COORDINATION AND COOPERATION

- A. It shall be the Contractor's responsibility to schedule and coordinate their work with the schedule of the General Contractor so as to progress the work expeditiously, and to avoid unnecessary delays.
- B. Contractor shall fully examine the drawings and specifications for other trades and shall coordinate the installation of their work with the work of the other contractors. Contractor shall consult and cooperate with the other contractors for determining space requirements and for determining that adequate clearance is allowed with respect to their equipment, other equipment and the building. The Design Professional reserves the right to determine space priority of the contractors in the event of interference between piping, conduit, ducts and equipment of the various contractors.
- C. Conflicts between the drawings and the specifications or between the requirements set forth for the various contractors shall be called to the attention of the Design Professional. If clarification is not asked for prior to the taking of bids, it will be assumed that none is required, and that the Contractor is in agreement with the drawings and specifications as issued. If clarification is required after the contract is awarded, such clarification will be made by the Design Professional and their decision will be final.
- D. Special care shall be taken for protection for all equipment. All equipment and material shall be completely protected from weather elements, painting, plaster, etc., until the project is substantially completed. Damage from rust, paint, scratches, etc., shall be repaired as required to restore equipment to original condition.

- E. Protection of all equipment during the painting of the building shall be the responsibility of the Painting Contractor, but this shall not relieve Contractor of the responsibility for checking to assure that adequate protection is being provided. Refer to Division 09 for painting protection.
- F. Where the final installation or connection of equipment in the building requires the contractor to work in areas previously finished by the General Contractor, the Electrical Contractor shall be responsible that such areas are protected and are not marred, soiled or otherwise damaged during the course of such work. Electrical Contractor shall arrange with the General Contractor for patching and refinishing of such areas which may be damaged in this respect.

1.09 OPENINGS, CUTTING AND PATCHING

- A. Refer to Division 1 for additional cutting and patching information.
- B. Conduits and sleeves passing through all fire or smoke rated floors, roofs, walls, and partitions shall be provided with firestopping. Space between wall/floor and conduit or sleeve shall be sealed with UL listed intumescent fire barrier material equivalent to rating of wall/floor. Where conduit or sleeves pass through floors, roofs, walls and partitions that are not fire or smoke rated, penetrations shall be sealed with grout or caulk.
- C. New structure:
 - 1. Contractor will coordinate the placing of openings and lintels in the new structure as required for the installation of the electrical work with the General Contractor.
 - 2. Contractor shall furnish to General Contractor the accurate locations and sizes for required openings, but this shall not relieve Contractor of the responsibility of checking to assure that proper size openings are provided. When additional cutting and patching is required due to Contractor's failure to coordinate this work, Contractor shall make arrangements for the cutting, patching, and painting required.
- D. Existing Structure:
 - 1. Contractor shall provide cutting, lintels and patching, and patch painting in the existing structure, as required for the installation of their work, and shall furnish lintels and supports as required for openings.
 - 2. Cutting of structural support members will not be permitted without prior approval of the Design Professional. Extent of cutting shall be minimized; use core drills, power saws or other machines which will provide neat, minimum openings.
 - 3. Patching shall match adjacent materials and surfaces and shall be performed by craftsmen skilled in the respective craft required.
- E. Conduits and wireways passing through all fire or smoke rated floors, roofs, walls, and partitions shall be provided with firestopping. Space between wall/floor and conduits, sleeves and/or wireways, shall be sealed with UL listed intumescent fire barrier material equivalent to rating of wall/floor. Where conduits, sleeves and/or wireways pass through floors, roofs, walls and partitions that are not fire or smoke rated, penetrations shall be sealed with grout or caulk.
- F. For exterior walls below grade, sleeves shall be cast iron. Space between sleeve and conduit shall be sealed with modular mechanical rubber links tightened with bolts as made by Thunderline Corporation, Wayne, Michigan 48184. Waterproofing of conduit penetrations in exterior walls shall be coordinated with waterproofing contractor.

1.10 EXCAVATING AND BACKFILLING

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

- B. Backfill about the structures shall be placed, when practicable, as the work of construction progresses. Backfilling on or against concrete work shall be done only when directed. Backfilling of trenches shall progress as rapidly as the testing and acceptance of the finished sections of the work will permit and shall be carried to a crown approximately six (6) inches above the existing grades. In backfilling trenches, selected material shall be compacted firmly around and to a depth of not less than six (6) inches over the top of work in trench. All fill and backfill and rough grading shall be compacted thoroughly in layers and shall be brought up to within six (6) inches of finished grades. All fill and backfill shall be sand or pit run sand/gravel graded from 1" size downward.

1.11 MATERIALS AND EQUIPMENT

- A. All materials and equipment shall be the standard product of a reputable U.S.A. manufacturer regularly engaged in the manufacture of the specified item unless authorized in writing by Design Professional. Where more than one unit is required of the same system, they shall be furnished by the same manufacturer except where specified otherwise.
- B. All material and equipment shall be installed in strict accordance with the manufacturer's recommendations.
- C. The equipment specifications cannot deal individually with any minute items such as parts, controls, devices, etc., which may be required to produce the equipment performance and function as specified, or as required to meet the equipment guarantees. Such items when required shall be furnished as part of the equipment, whether or not specifically called for.

1.12 SUBMITTALS

- A. Contractor shall furnish, to the Design Professional, complete sets of shop drawings and other submittal data. Contractor shall review and sign shop drawings before submittal. Refer to Division 01 specifications for additional requirements. Refer to Section 01 3000 - Administrative Requirements for additional requirements.
- B. Shop drawings shall be bound into sets and cover related items for a complete system as much as practical and shall be identified with symbols or "plan marks" used on drawings. Incomplete, piecemeal or unbound submittals will be rejected.
- C. Submittals required by the various sections of the Project Manual include, but are not necessarily limited to those identified in the submittal schedule below.
- D. After award of contract, the contractor shall provide a completed submittal schedule including dates that the submittals will be to the Design Professional for review.
- E. Submit required information on the following items:

SPEC SECTION	EQUIPMENT	DETAIL DWGS	PROD DATA	PROD SAMPLES	INSTALL METHODS	O & M MANUAL	CERTIFICATE OF SYSTEM DEMONSTRATION	OTHER (SEE NOTES)
26 05 19	Low-Voltage Power Conductors and Cables		X			X		
26 05 33	Raceway and Boxes for Electrical Systems		X			X		
26 05 73	Short Circuit-Coordination Study/Arc Flash Hazard Analysis		X			X		1
26 09 23	Lighting Control Systems	X	X			X	X	
26 22 00	Low-Voltage Transformers	X	X			X	X	
26 24 16	Panelboards	X	X			X	X	

**JOHNSON COUNTY ADMINISTRATION AND HEALTH &
HUMAN SERVICES BUILDINGS REMODELING PROJECT
IOWA CITY, IOWA**

PROJECT NO. 21412000

SPEC SECTION	EQUIPMENT	DETAIL DWGS	PROD DATA	SAMPLES	INSTALL METHODS	O & M MANUAL	CERTIFICATE OF SYSTEM DEMONSTRATION	OTHER (SEE NOTES)
26 27 26	Wiring Devices		X			X		
26 28 16	Enclosed Switches and Circuit Breakers		X			X	X	
26 29 23	Variable Frequency Motor Controllers		X			X	X	
26 43 13	Surge Protective Devices		X			X		
26 50 00	Lighting	X	X			X	X	
NOTES:								
1. Provide preliminary report; refer to specification section for requirements.								

- F. Design Professional will review shop drawings solely to assist contractors in correctly interpreting the plans and specifications.
- G. Contract requirements cannot be changed by shop drawings which differ from contract drawings and specifications.

1.13 OPERATION AND MAINTENANCE MANUALS

- A. Operation and maintenance manuals shall be submitted to Design Professional. Refer to Division 01 specifications for additional information.
- B. Submit manuals in duplicate upon completion of the job. Manuals shall be bound in a three ring hard-backed binder. Front cover and spine of each binder shall have the following lettering done:

OPERATION
AND
MAINTENANCE
MANUAL
FOR
ELECTRICAL SYSTEMS

(PROJECT NAME)
(LOCATION)
(DATE)

SUBMITTED BY
(NAME AND ADDRESS OF CONTRACTOR)

- C. Provide a master index at the beginning of manual showing items included. Use plastic tab indexes for sections of manual. Each section shall contain the following information for equipment furnished under this contract:
 - 1. Equipment and system warranties and guarantees.
 - 2. Installation instructions.
 - 3. Operating instructions.
 - 4. Maintenance instructions.
 - 5. Spare parts identification and ordering list.
 - 6. Local service organization, address, contact and phone number.
 - 7. Shop drawings with reviewed stamp of Design Professional and Contractor shall be included, if applicable, along with the items listed above.
- D. Items to be included shall be those listed in shop drawing section.

1.14 TESTS AND DEMONSTRATIONS

- A. All systems shall be tested by Contractor and placed in proper working order prior to demonstrating systems to Owner.

- B. Contractor shall test the electrical grounding system resistance in accordance with Specification Section 26 05 26 – Grounding and Bonding for Electrical Systems and submit a report to Design Professional stating the results.
- C. Prior to acceptance of the electrical installation, the Contractor shall demonstrate to the Owner, or their designated representatives, all essential features and functions of all systems installed, and shall instruct the Owner in the proper operation and maintenance of such systems. Owner instruction shall be provided for the following systems:

Sections	Description	Hrs. on Site	Hrs. off Site	Presented By	Others Present	Remarks
26 22 00 26 24 13 26 24 16 26 24 19 26 28 16	Electrical Dist. System	4		Contractor		
26 29 23	Motor Controls	2		Contractor		
26 09 23 26 50 00	Building Lighting Controls	8		Manufacturer's Representative	Contractor	2

REMARKS:

1. Perform complete system test at time of instruction.
2. Refer to 26 09 23 for training requirements. Multiple training sessions will be required.
3. Any unused hours shall be used at Owner's discretion during the first year of occupancy.

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

CERTIFICATE OF SYSTEM DEMONSTRATION

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

- A. Project:
- B. System(s):
- C. Contractor's representatives giving instruction and demonstration:

Contractor: _____

NAMES	DATE	HOURS

- D. Owner's representatives receiving instruction:

Owner: _____

NAMES	DATE	HOURS

- E. Acknowledgement of demonstration:

Contractor's Representative:

_____ signature

_____ date

Owner's Representative:

_____ signature

_____ date

1.15 SUBSTITUTIONS

- A. To obtain approval to use unspecified equipment, Bidding Contractors (not equipment supplier, manufacturers, etc.) shall submit written requests to Design Professional at least 10 days prior to bid due date. Requests shall clearly describe the equipment for which approval is being requested. Include all data necessary to demonstrate that equipment's capacities, features and performance are equivalent between specified equipment and equipment for which approval is being requested. If the equipment is acceptable, Design Professional will approve it in an addendum. Design Professional will, under no circumstances, be required to prove that an item proposed for substitution is or is not of equal quality to the specified item.

1.16 ACCEPTABLE MANUFACTURERS

- A. In most cases, equipment specifications are based on a specific manufacturer's type, style, dimensional data, catalog number, etc. Listed with the base specification, either in the manual or on the plan schedules are acceptable manufacturers approved to bid products of equal quality. These manufacturers are encouraged to submit to Design Professional at least 8 days prior to the bid due date drawings and catalog numbers of products to be bid as equals.
- B. Manufacturers, who do not submit prior to bidding, run the risk of having the product rejected at time of shop drawing submittal. Extra costs associated with replacing the rejected product shall be the responsibility of the Contractor and/or the manufacturer.
 - 1. If Contractor chooses to use a manufacturer listed as an equal, it shall be their responsibility to assure that the manufacturer has complied with the requirements in 'A' above. Contractor shall assume all responsibility for physical dimensions, operating characteristics, and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of using the alternate manufacturer.
 - 2. Where a model or catalog number is provided, it may not be inclusive of all product requirements. Refer to additional requirements provided on the plans or in the specifications as required. Similarly, there may be additional requirements included in the model or catalog number that are not specifically stated. These requirements shall also be met.

1.17 WARRANTY

- A. Refer to Divisions 00 and 01 for information on warranties and correction of work within the warranty period.
 - 1. If a warranty or warranty period are not defined in Division 00 or 01, then the start of all warranty periods shall be the date of Substantial Completion and the length of the warranty shall be for one year.
 - a. If construction is phased with distinct and separate Substantial Completion dates for portions of the building and/or systems, separate warranties shall be provided for each of these phased areas and/or systems.
 - b. The entire Electrical system, including all sub-systems, shall be guaranteed against defect in materials and installation for the duration of the warranty period. Any malfunctions or defects which occur within the warranty period shall be promptly corrected without cost to the Owner. This guarantee shall not limit or void any manufacturer's express or implied warranty.
- B. Refer to other Division 26 sections for systems, equipment, or material requiring extended warranties.
- C. The date of systems/equipment startup or equipment/material shipment to the site shall not be considered the notable date with relation to the warranty of that item. All systems, equipment, material, etc., shall have the same start date with respect to the warranty period.
- D. Systems, equipment or material put into use to facilitate construction activities (e.g. testing and balancing, commissioning, temporary conditioning, etc.) prior to the start of the warranty period shall not impact the length of the warranty in any way.

1.18 CHANGES IN THE WORK

- A. Refer to Divisions 00 and 01.

1.19 COMPLETION

- A. Systems, at time of completion, shall be complete, efficiently operating, nonhazardous and ready for normal use by the Owner.
- B. When all the electrical work is complete Contractor shall thoroughly clean all material and equipment installed as a part of this contract and leave all equipment and material in new condition.
- C. Contractor shall clean up and remove from the site all debris, excess material and equipment left during the progress of this contract at job completion.

1.20 CLEANING

- A. Prior to assembly of electrical equipment, all loose dirt, scale, oil, and other foreign matter on internal and exterior surfaces shall be removed by means consistent with good electrical practices.
- B. All temporary labels, stickers, etc., shall be removed from all fixtures and equipment. Name plates, ratings, instruction plates, etc., shall not be obscured by paint, insulation, or placement of units.
- C. Electrical equipment shall be thoroughly cleaned on the interior and exterior of equipment. This includes, but is not limited to: removal of wiring trimmings within electrical panels and dirt/debris from activation boxes.
- D. All light fixtures shall be wiped clean with all fingerprints and dust removed.

1.21 ACCESS DOORS

- A. When the Electrical Contractor provides any equipment requiring periodic servicing which will be concealed by non-accessible architectural construction, the Electrical Contractor shall provide a flush access door. The access door shall be equal to a Karp DSC 211 Universal access door or Nystrom APWB or type for the specific construction involved.
- B. Access doors in fire rated construction shall be fire rated and have U.L. label.
- C. Construction:
 - 1. Door and trim shall be 13 gauge steel, frames shall be 16 gauge steel.
 - 2. Trim shall be of one piece construction.
 - 3. Finish shall be prime coat of rust inhibitive baked grey enamel.
 - 4. Hinges shall be concealed, offset, floating hinge.
 - 5. Locks shall be flush, screwdriver operated with stainless steel cam and studs.

1.22 TEMPORARY UTILITIES

- A. Refer to Specification Division 1 for specific requirements concerning temporary utilities.

1.23 CONCRETE EQUIPMENT PADS

- A. Provide equipment housekeeping pads for all floor mounted equipment. Anchor equipment to concrete equipment pads according to equipment manufacturer's recommendations.
 - 1. Construct concrete bases of dimensions indicated or as required to be 4 inches larger in both directions than supported unit. Pads to be a minimum of 4" in height unless noted otherwise.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

5. Install anchor bolts according to manufacturer's recommendations and to elevations required for proper attachment to supported equipment.
6. Use 3000-psi compressive strength concrete with #3 rebar 12" O.C.

END OF SECTION 26 00 10

**SECTION 26 05 00
COMMON WORK RESULTS FOR ELECTRICAL**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 00 10 - Electrical General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

- A. This section includes the following:
 - 1. Demolition.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. All materials removed shall be the property of the removing contractor and shall be removed from the site unless otherwise specified.

PART 3 - EXECUTION

3.01 GENERAL

- A. Demolition shall be accomplished by the proper tools and equipment for the work to be removed. Personnel shall be experienced and qualified in the type of work to be performed.

3.02 EXAMINATION

- A. Verify field measurements and circuiting arrangements are as shown on Drawings.
- B. Verify that abandoned wiring and equipment serve only abandoned facilities.
- C. Demolition Drawings are based on casual field observation. Report discrepancies to Owner before disturbing existing installation.

3.03 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.
- B. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- C. Existing Electrical Services: Maintain existing system in service. Disable system only to make switchovers and connections. Obtain permission from Owner at least 72 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.
- D. Existing Fire Alarm System: Maintain existing system in service in HHS and AME. Disable system only to make switchovers and connections. Notify Owner at least 72 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.
- E. Existing Telecommunications Systems: Maintain existing systems in service in HHS and AME. Disable systems only to make switchovers and connections. Obtain permission from Owner at least 72 hours before partially or completely disabling system.

3.04 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Demolish and extend existing electrical work under provisions of this Section.
- B. Remove, relocate, and extend existing installations to accommodate new construction. Extend existing installations using materials and methods as specified.

- C. Where electrical demolition interrupts power, fire alarm, or communications in areas outside the area of construction, contractor shall provide temporary extensions or connection to maintain the systems as operational.
- D. Remove abandoned wiring to source of supply.
- E. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- F. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.
- G. Disconnect and remove abandoned panelboards and distribution equipment.
- H. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- I. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- J. Repair adjacent construction and finishes damaged during demolition and extension work.
- K. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.
- L. Clean and repair existing materials and equipment which remain or are to be reused.

3.05 FLUORESCENT LAMP AND BALLAST DISPOSAL

- A. Unless noted otherwise, all existing fluorescent lamps and ballasts within light fixtures to be removed shall be assumed to contain mercury and PCB's respectively. These items need to be disposed of by a mercury and PCB Disposal Contractor, who shall be a subcontractor to Electrical Contractor. This Disposal Contractor shall have all local, state, and federal authorization for handling, transporting, and processing these materials. Disposal Contractor shall have pollution insurance and shall generate a Certificate of Disposal. Ballasts and all contaminated materials shall be incinerated. Lamps shall be recycled.
- B. Available Disposal Contractors
 - 1. Subject to compliance with requirements, below are available Contractors:
 - a. A-tec Recycling, Inc.
 - b. ALTA Resource Management Services, Inc.
 - c. Full Circle Ballast Recyclers
 - d. Midwest Lamp Recycling, Inc.

3.06 WORK BY OTHERS

- A. Unless specifically noted under other contracts, Electrical Contractor shall assume all required work shall be performed by him. In general, the following will be performed by others:
 - 1. General Contractor will remove any bases, floor fill, wall work and footings; neatly patch, match, complete and finish all affected surfaces.
 - 2. Mechanical Contractor will disconnect all mechanical services and remove pipe back to behind finish surfaces, close and cap ends of pipe.

3.07 OWNER'S RIGHT OF SALVAGE

- A. Owner may designate and have salvage rights to any material herein demolished by the Contractor.

END OF SECTION 26 05 00

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 00 10 - Electrical General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

- A. Contractor shall furnish all material, tools, labor, and supervision necessary to install all wiring systems.
- B. This section describes the basic materials and methods of installation for general wiring systems of 600 volts and less. Wiring for a higher voltage rating, if required, shall be as specified in other sections or called for on the drawings.

1.03 QUALITY ASSURANCE

- A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wire, cable, and connectors.
- B. UL Compliance: Comply with UL standards pertaining to wire, cable, and connectors.
- C. UL Labels: Provide electrical wires, cables and connectors which have been UL listed and labeled.
- D. NEMA/ICEA Compliance: Comply with applicable portions of NEMA/Insulated Cable Engineers Association standards pertaining to materials, construction and testing of wire and cable.
- E. ANSI/ASTM: Comply with applicable portions of ANSI/ASTM standards pertaining to construction of wire and cable.
- F. The materials used for wiring systems shall be the products of a manufacturer regularly engaged in the manufacturing of the specified material.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for each product specified.

PART 2 - PRODUCTS

2.01 WIRE AND CABLE

- A. All wire and cable for power, lighting, control, and signal circuits shall have copper conductors of not less than 98% conductivity and shall be insulated to 600 V. Conductor sizes #12 AWG and smaller shall be solid, conductor sizes #10 AWG and larger shall be stranded.
- B. Minimum size conductors shall be #12 AWG for power and lighting.
- C. Type of wire and cable for various applications shall be as follows:
 - 1. Type THHN/THWN-2, or XHHW-2 (90 deg. C) use for branch circuits, panel and equipment feeders in dry locations.
 - 2. Type XHHW-2 (90 deg. C) use for branch circuits, panel and equipment feeders located underground and in wet and dry locations.
 - 3. 2-Hour Fire Rated Cable System. UI 2196 listed for horizontal and vertical installations.
 - a. Pentair System 1850 Type MI mineral insulated cable.
 - b. Omni Cable VITALink Type MC 2-hour rated power cable.
 - c. RHW-2 based cable systems are not acceptable.
 - d. Provide all proprietary terminations and components for a complete listed system.
 - 4. Type UF use where permitted by other sections or by the drawings for underground burial branch circuits.
 - 5. For all vibration type installations (i.e. motors, etc.), provide stranded type conductors.

2.02 CONDUCTOR COLOR CODING

- A. Wiring systems shall be color coded. Conductor insulation shall be colored. Colors shall be assigned to each conductor as described below and carried throughout all main and branch circuit distribution. When necessary to use tape, use colored tape on black wire. Do not use colored tape on colored wire.

	120/208V - Wye	277/480V - Wye
Phase 'A' Conductor	Black	Brown
Phase 'B' Conductor	Red	Orange
Phase 'C' Conductor	Blue	Yellow
Neutral Conductor	White*	Grey*
Equipment Grounding Conductor	Green	Green
Isolated Grounding Conductor	Green w/Yellow Stripe	Green w/Yellow Stripe

* For branch circuits with non-shared neutral conductors, provide colored tracer to match associated phase conductor. Tracers shall be Black, Red, Blue, Brown, Orange, or Yellow.

** Use red and black for phases which are 120V to neutral. Use orange for "wild leg".

2.03 CONNECTORS

- A. Twist-on Wire Connectors.
1. Dry Locations. 600V rated, UL 486C listed, Ideal Industries 451/452/454 or equal by 3M or Thomas and Betts. Use for #8 and smaller.
 2. Wet locations. 600V rated, UL 485D listed with pre-filled silicone sealant. Ideal industries 61/62/63 series or equal by 3M or Thomas and Betts. Use for #8 and smaller. To be used for all above ground splices in exterior locations and interior wet locations.
 3. Underground locations. 600V rated, UL 485D listed for direct burial with pre-filled silicone sealant. Ideal Industries 60/64/66 series or equal buy 3M or Thomas and Betts. Use for #8 and smaller. To be used for all below ground and in-slab locations.
- B. Conductor Taps and Splices.
1. Dry Locations. 600V rated, UL 486A/B listed, insulated mechanical termination. IlSCO ClearTap PCT or equal by Burndy. Use for #6 and larger.
 2. Wet and Underground Locations. 600V rated, UL 486D listed, watertight mechanical termination suitable for direct burial in earth. IlSCO SafetySub PDSS or equal by Burndy or 3M. Use for #6 and larger.
 3. Insulation piercing taps are not allowed.
 4. Split bolt connectors and splices are not allowed.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Wire shall not be installed in the conduit system until the building is enclosed and masonry work is completed.
- B. Conduit shall be swabbed free of moisture and debris prior to pulling in wiring. Pull mouse through conduits prior to pulling conductors.

3.02 INSTALLATION

- A. All cable for major feeders shall be continuous from origin to termination, unless otherwise indicated.
- B. Branch circuit conductor sizes shall be increased to maintain a maximum 3% voltage drop.
1. 120V, 20A homeruns shall be sized as follows based on one-way circuit length:
 - a. 0-80': #12 AWG
 - b. 81'-140': #10 AWG

- c. 141'- 210': #8 AWG
- d. 211' and over: #6 AWG
- 2. 277V, 20A homeruns shall be sized as follows based on the one-way circuit length:
 - a. 0-200': #12 AWG
 - b. 201'-300': #10 AWG
 - c. 301' and over: #8 AWG
- C. Conductors for 208V and 480V systems shall be installed in separate raceway systems.
- D. Splices shall be made only in accessible junction boxes or handholes.
- E. All power feeder cable shall be pulled with the use of approved pulling compound or powder. Compound must not deteriorate conductor or insulation.
- F. If conductor insulation is damaged during installation, replace entire conductor.
- G. Use pulling means, including fish tape, cable or rope which cannot damage raceway.
- H. Install exposed cable, parallel and perpendicular to surfaces or exposed structural members and follow surface contours, where possible.
- I. Keep branch circuit conductor splices to a minimum.
- J. The continuity of circuit conductors shall not be dependent on service connections such as lamp holders, receptacles, etc., where the removal of such devices would interrupt the continuity.
- K. Provide separate green equipment ground conductor throughout entire electrical system.
- L. Isolated ground conductors shall be kept isolated from the equipment grounding system from the outlet back to where the system is derived.
- M. All branch circuits shall have dedicated neutrals.
- N. Install 2-hour rated cable systems in strict accordance with the manufacturer's instructions and the UL Listing.

3.03 FIELD QUALITY CONTROL

- A. Prior to energizing system, test cable and wire for continuity of circuitry, and for short circuits. Correct malfunctions when detected.
- B. After wire terminations are complete, energize circuitry and demonstrate functioning in accordance with requirements.

END OF SECTION 26 05 19

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**SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

PART 1 - GENERAL

1.01 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 00 10 - Electrical General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

- A. Extent of grounding work is indicated by drawings and shall comply with NEC.
- B. Applications of grounding work in this section include the following:
 - 1. Underground metal piping.
 - 2. Underground metal water piping.
 - 3. Underground metal structures.
 - 4. Metal building frames.
 - 5. Grounding electrodes.
 - 6. Grounding rods.
 - 7. Ground loops.
 - 8. Separately derived systems.
 - 9. Service equipment.
 - 10. Enclosures.
 - 11. Equipment.
- C. Requirements of this section apply to electrical grounding work specified elsewhere in these specifications.

1.03 QUALITY ASSURANCE

- A. NEC Compliance: Comply with NEC requirements as applicable to materials and installation of electrical grounding systems, associated equipment and wiring. Provide grounding products which are UL-listed and labeled.
- B. UL Compliance: Comply with applicable requirements of UL Standards Nos. 467 and 869 pertaining to electrical grounding and bonding.
- C. IEEE Compliance: Comply with applicable requirements of IEEE Standard 142 and 241 pertaining to electrical grounding.

PART 2 - PRODUCTS

2.01 GROUNDING SYSTEMS

- A. Materials and Components
 - 1. General: Except as otherwise indicated, provide electrical grounding systems indicated; with assembly of materials, including, but not limited to, cables/wires, connectors, terminals (solderless lugs), grounding rods/electrodes and plate electrodes, bonding jumper braid, surge arresters, and additional accessories needed for complete installation. Where more than one type unit meets indicated requirements, selection is Installer's option. Where materials or components are not indicated, provide products complying with NEC, UL, IEEE, and established industry standards for applications indicated.
 - 2. All components shall be listed under ANSI/UL 467 – “Grounding and bonding Equipment”.
 - 3. Raceways: Provide raceways, and electrical boxes and fittings complying with Division 26, Section 26 05 33 – Raceway and Boxes for Electrical Systems.
 - 4. Conductors: Unless otherwise indicated, provide electrical grounding conductors for grounding connections matching power supply wiring materials and sized according to NEC.

- B. Connectors
 - 1. Lugs: Grounding and bonding conductors shall terminate in two-hole, long barrel irreversible compression lugs, Burndy YGA series or equal by Blackburn, IlSCO, or Anderson.
 - 2. Exothermic welds: Graphite mold designed for the specific connection type required. Weld metal used for grounding connections shall contain copper oxide, aluminum and not less than 3% tin as the wetting agent. Exothermic weld products by Erico, Harger or approved equal.
 - 3. Ground clamps for pipes: Bronze with pad for 2-hole lug, Burndy GAR-TC series or equal by Blackburn, IlSCO, or Anderson.
- C. Ground bars: Ground bars shall be 4" wide, 1/4" thick solid copper with insulating bushings and 7/16" holes. Hole spacing to accommodate 3/4", 1" and 1-3/4" lugs. Ground bars shall be a minimum of 12" long, refer to plans for specific length.
- D. Grounding Rods
 - 1. Ground Rods:
 - a. Copper clad steel, 3/4" dia. x 10' for service entrance.
 - b. Copper clad steel, 5/8" dia x 8' for other applications.

PART 3 - EXECUTION

3.01 INSTALLATION OF ELECTRICAL GROUNDING

- A. General: Install electrical grounding systems where shown, in accordance with applicable portions of NEC, with NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products comply with requirements and serve intended functions.
- B. Coordinate with other electrical work as necessary to interface installation of electrical grounding system with other work.
- C. Install bonding jumpers with ground clamps on water meter piping to electrically bypass water meters.
- D. Install clamp-on connectors only on thoroughly cleaned metal contact surfaces, to ensure electrical conductivity and circuit integrity.
- E. When making ground and ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.
- F. Bury ground rods vertically with rod top a minimum of 2 feet below grade, or with rod top terminated in a gravel filled ground well. If extensive rock formation is encountered, inform the Design Professional and relocate ground rods, or provide supplemental ground rods as directed by the Design Professional.
- G. A No. 6 AWG minimum stranded copper wire shall be furnished and exothermically welded to all of the ground rods.
- H. Protect ground conductors from physical and environmental damage. Wherever possible, and where indicated, grounding electrode and bonding conductors shall be enclosed in a non-metallic raceway. Where ground conductors are subject to physical damage, install in galvanized rigid steel conduit with grounding bushings on each end. Locate exposed conductors which must extend from a concrete surface as close as possible to a corner. Where conductors are required to be exposed, as in the connection to the main ground bus, support ground conductors by corrosion resistant metallic hardware at 4-foot intervals or less.
- I. Exothermic Welding
 - 1. Clean and dry the surface to be welded. Wire brush or file the point of contact to a clean bare metal surface.
 - 2. Use welding cartridges and molds for the type of weld recommended by the manufacturer and perform welding in accordance with the manufacturer's recommendations. Worn or damaged molds not to be used.

3. Test all welds by striking with a 2 pound steel hammer. Replace any defective welds.
 4. Where exothermic welds are made to a galvanized surface, remove the galvanizing using a grinding wheel to expose a clean surface. After welding, touch up the steel surface with zinc rich primer.
- J. Provide separate green ground conductor throughout entire electrical system sized as required by the NEC.
- K. Conduit Grounding
1. Bond all metallic conduit systems together to provide a continuous electrical ground path. Bond metallic conduits to other conduit components using insulated ground bushings when required. Connect ground bushings to the grounding system using conductors sized in compliance with NEC.
 2. Provide ground conductors in non-metallic conduits in accordance with the NEC.
- L. All portions of the metal building structure that are not electrically continuous shall be bonded to the service entrance grounding electrode system.
- M. Isolated Grounding (IG) conductors shall be green colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- N. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

END OF SECTION 26 05 26

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**SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS**

PART 1 - GENERAL

1.01 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 00 10 - Electrical General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

- A. Provide materials, labor and supervision as necessary to provide hangers and supports for conduit, fixtures and equipment.

1.03 QUALITY ASSURANCE

- A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical supporting devices.
- B. ANSI/NEMA Compliance: Comply with applicable requirements of ANSI/NEMA Std. Pub. No. FB 1, "Fittings and Supports for Conduit and Cable Assemblies".
- C. NECA Compliance: Comply with National Electrical Contractors Association's "Standard of Installation" pertaining to anchors, fasteners, hangers, supports, and equipment mounting.
- D. UL Compliance: Provide electrical components which are UL listed and labeled.

PART 2 - PRODUCTS

2.01 MANUFACTURED SUPPORTING DEVICES

- A. Manufacturer: Subject to compliance with requirements, provide channel systems of one of the following:
 - 1. B Line Systems, Inc.
 - 2. Thomas & Betts, Superstrut
 - 3. Unistrut Div.; Tyco International
 - 4. Globestrut
- B. General: Provide supporting devices; complying with manufacturer's standard materials, design and construction in accordance with published product information, and as required for a complete installation; and as herein specified. Where more than one type of device meets indicated requirements, selection is Installer's option.
- C. Conduit Cable Supports: Provide cable supports with insulating wedging plug for non armored type electrical cables in risers; construct for rigid metal conduit; type wire as indicated; construct body of malleable iron casting with hot dip galvanized finish.
- D. U Channel Strut Systems: Provide U channel strut system for supporting electrical equipment, 16 gauge hot dip galvanized steel, of types and sizes indicated; construct with 9/16" dia. holes, 8" o.c. on top surface, with standard green finish, and with the following fittings which mate and match with U channel:
 - 1. Fixture hangers.
 - 2. Channel hangers.
 - 3. End caps.
 - 4. Beam clamps.
 - 5. Wiring stud.
 - 6. Thinwall conduit clamps.
 - 7. Rigid conduit clamps.
 - 8. Conduit hangers.
 - 9. U bolts

PART 3 - EXECUTION

3.01 INSTALLATION OF SUPPORTING DEVICES

- A. Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to ensure supporting devices comply with requirements.
- B. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.
- C. Conduit hangers and support devices shall be approved type for the method of supporting required. Size supports as necessary per manufacturer's recommendations for the weight being supported. All hangers and supports shall have galvanized finish or other approved corrosion resistance finish. In general, hangers and supports shall be as follows:
 - 1. Where single or multiple run of conduit is routed on surface of structure; use conduit clamps mounted on U channel strut so as to maintain not less than 1" clearance between conduit and structure.
 - 2. Where single run of conduit is suspended from overhead; use split ring conduit clamp suspended by 3/8" steel drop rod.
 - 3. Where multiple parallel runs of conduit are suspended from overhead; use split ring conduit clamps uniformly spaced and supported on trapeze hangers fabricated of U channel strut, suspended by not less than two steel drop rods.
 - 4. Where circuit voltage is above 600 volts, conduit clamps shall be provided with insulating bushings of dielectric strength as required.
 - 5. Where conduit is buried in concrete floor topping; anchor conduit to structural floor with one-hole jiffy clamps.
 - 6. Maximum hanger and support spacing shall be in accordance with NEC.
- D. Hangers and supports shall be anchored to structure as follows:
 - 1. Hangers and supports anchored to poured concrete, use malleable iron or steel concrete inserts attached to concrete forms.
 - 2. Hangers or supports anchored to precast concrete, use self-drilling expansion shields. Expansion shields may be used where concrete inserts have been missed or additional support is required in poured concrete.
 - 3. Hanger or supports anchored to structural steel, use beam clamps and/or steel channels as required by structural system.
 - 4. Hangers or supports anchored to metal deck, use spring clips or approved welding pins. Maximum permissible load on each hanger shall not exceed 50 pounds.
 - 5. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls.
 - 6. Use sheet metal screws in sheet metal studs and wood screws in wood construction.
- E. The following is not permitted:
 - 1. Attaching supports and hangers to piping, ductwork, mechanical equipment, or conduit.
 - 2. Use of powder-actuated anchors.
 - 3. Drilling of structural steel members.
- F. Fixtures on plastered or acoustical ceilings shall not be supported directly on ceiling tile. Provide metal bar hangers or U channel strut attached to ceiling supports.
- G. Where disconnect switches and panels cannot be mounted on wall, provide support racks fabricated of structural steel or U channel strut.
- H. Where disconnects or equipment is designated as NEMA 4X, provide stainless steel support and hardware.

- I. Provide concrete bases and pads for transformers, switchgear, free standing panels, generators, outdoor lighting poles and other equipment requiring bases, except where drawings indicate that such bases and pads are to be furnished by the General Contractor. Pads shall be 3.5" tall and extend 4" beyond footprint of equipment. Furnish all equipment anchor bolts and installation for their proper and accurate location. All concrete work and reinforcing shall comply with General Specifications.

END OF SECTION 26 05 29

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SECTION 26 05 33
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 00 10 - Electrical General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

- A. Contractor shall furnish all materials, tools labor and supervision necessary to fabricate and install complete conduit systems.
- B. Conduit systems shall be provided for all wiring, except where the drawings or other sections of the specifications indicate that certain wiring may be installed in cable trays, surface raceway, underfloor raceway, wireways and/or auxiliary gutters.
- C. Types of raceways in this section include the following:
 - 1. Rigid metal conduit.
 - 2. Intermediate metal conduit.
 - 3. Electrical metallic tubing.
 - 4. Flexible metal conduit.
 - 5. Liquid tight flexible metal conduit.
 - 6. Rigid nonmetallic conduit.
 - 7. MC cable.
 - 8. Surface metal raceways.
- D. Provide factory painted red conduit for fire alarm system.
- E. Contractor shall furnish all material, tools, labor and supervision necessary to install electrical boxes and fittings as required by drawings and specifications.
- F. Types of electrical boxes and fittings in this section include the following:
 - 1. Outlet boxes.
 - 2. Junction boxes.
 - 3. Pull boxes.
 - 4. Wireways
 - 5. Activation boxes.
 - 6. Handholes
- G. Telecommunications Raceway Requirements:
 - 1. The term “telecommunications” includes all low voltage technology systems including voice and data, access control, video surveillance, intrusion detection, audio video, induction loop, paging, intercom, nurse call, school bell and/or clock systems. The term does not include fire alarm system, which is addressed separately in the plans and specifications.
 - 2. Contractor shall provide and install telecommunications boxes and conduits, including wall sleeves unless otherwise noted.
 - 3. Below grade building entrance conduits within the building footprint shall be schedule 40 electrical PVC unless otherwise noted. Long sweep ninety-degree elbows for under building footprint conduits shall be fiberglass sweeps with PVC schedule 40 conduit connectors built into the ends of the sweeps. Sweeps of 4” diameter shall be 36” minimum radius.
 - 4. Below grade conduits for low voltage system cabling are not acceptable unless specifically directed. Below grade entrance conduits and floor boxes in slab on grade are exceptions to this rule.

5. Underground conduits outside the building footprint shall be continuous orange HDPE (high density polyethylene) with 1250 pound braided mule tape used as pull string unless otherwise noted. Round pull string or other rope is not acceptable for pulling due to risk of raceway damage. HDPE manufacturer approved waterproof couplers shall be used for conduit type transition. HDPE to HDPE connection shall be hot fusion splice.
6. HDPE shall be minimum SDR 17 wall thickness for 2" diameter and smaller. The wall thickness shall be minimum SDR 11 for sizes larger than 2" diameter.
7. All below grade conduits shall be plugged at each end during construction to keep water, mud, rodents, etc., out.
8. All below grade entrance conduits shall be plugged on each end with removable mechanical plugs to keep water from entering the building for the life of the building. These plugs shall be installed inside the building above slab, and also at the first hand-hole outside the building (or where the conduits terminate underground). These plugs shall also seal around the utility entrance cables, including in and around all sub-ducts for a complete watertight seal. These mechanical plugs shall be as found on www.innerduct.com or engineer approved equivalent. Coordinate with the utility to determine size of cables for the plug inserts required. This work shall be completed before the Owner occupies the building.
9. All below grade exterior conduits shall have a tracer wire with adequate slack loop at each end for owner to conveniently connect and trace. All tracer wires shall protrude from closed hand holes so tracing may be accomplished without lifting the hand hole lid.
10. Interior building, above grade conduits and sleeves shall be EMT unless otherwise noted. PVC is never acceptable above grade.
11. All interior conduits shall have bushings installed during conduit installation. Completed individual installations shall have bushings installed same business day.
12. All interior conduits shall have pull strings, except sleeves which are less than 4' long. EMT conduits shall receive standard round cable pull string (multi-strand plastic twine type).
13. Minimum interior conduit size for all information jacks (voice data cabling) shall be 1" unless otherwise noted.
14. Minimum interior conduit size for audiovisual shall be 1" unless otherwise noted. Junction (pull) boxes shall be added at a maximum of 100' of raceway distance, and also for a maximum of 180 degrees of bend radius.
15. Minimum interior conduit size for video surveillance, intrusion detection, paging, intercom, nurse call, school bells and/or clock systems shall be 3/4" unless otherwise noted.
16. Access control system conduit sizes at the door location shall be per the access control detail found on the drawings. The conduit from the door location to the access control head end which contains all conductors needed for all access control functions at that door (may be individual conductors but is often one large composite cable) shall be minimum 3/4".
17. Boxes for all low voltage systems in stud walls shall be metallic 5"x5"x2.875" with single gang mud ring unless otherwise noted.
18. Boxes in masonry walls shall be minimum 3.5" deep. single gang, unless otherwise noted.
19. Wiremold surface raceway for all low voltage systems shall be minimum V2400 unless noted otherwise.
20. Wiremold surface boxes for all low voltage shall be minimum 2.5" deep single gang, unless otherwise noted.
21. Conduits inside walls which feed the low voltage side of dual compartment Wiremold shall be minimum 1.25"
22. Contractor shall provide and install hand holes for cable pulling in buried raceway at a maximum interval of 500'.

1.03 QUALITY ASSURANCE

- A. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.

- B. UL Compliance and Labeling: Comply with provisions of UL safety standards pertaining to electrical raceway systems; and provide products and components which have been UL listed and labeled.
- C. NEC Compliance: Comply with requirements as applicable to construction and installation of raceway systems.
- D. The materials used in the fabrication of the raceway system shall be products of a manufacturer regularly engaged in the manufacturing of the specified material.
- E. NEC compliance: Comply with NEC as applicable to construction and installation of electrical wiring boxes and fittings.
- F. UL Compliance: Provide electrical boxes and fittings which have been UL listed and labeled.
- G. ANSI/NEMA Standards Compliance: Comply with ANSI C 134.1 (NEMA Standards Pub No. OS 1) as applicable to sheet steel outlet boxes, covers and box supports.

1.04 SUBMITTALS

- A. Raceway Product Data: Submit manufacturer's data including specifications, installation instructions and general recommendations, for each type of raceway listed below. Include data substantiating that materials comply with requirements for the following:
 - 1. Raceway
 - 2. MC Cable
 - 3. Surface Metal Raceway
- B. Activation Box Product Data: Submit manufacturer's data including specifications, installation instructions and general recommendations for each type of activation box required. Include data substantiating that units comply with requirements.
- C. In-Ground Handhole Product Data: Submit manufacturer's data including specifications, installation instructions and general recommendations for each type of handhole required. Include data substantiating that units comply with requirements.

PART 2 - PRODUCTS

2.01 RACEWAYS

- A. General: Provide metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) for each service indicated. Where types and grades are not indicated, provide proper selection determined by Installer to fulfill wiring requirements, and comply with applicable portions of NEC for raceways. Conduit shall be used where concealed in permanent wall construction or in ceiling plenums. Surface raceway shall be used where exposed in finished regularly occupied areas. See 26 0553 for color conduit requirements.
- B. Rigid Conduit: Full weight, threaded, rigid steel conduit, galvanized inside and out by hot dip or electro galvanized process. Additional protection by electrostatically applied baked coating. Thread protective caps and couplings. Use for all feeders larger than 2 1/2" in size.
- C. Intermediate Metal Conduit (IMC): May be used as approved by code where rigid conduit is specified, except shall not be used for conduit buried in earth fill.
- D. Electrical Metallic Tubing: Thin wall, electrically welded cold rolled steel conduit, galvanized inside and out by electro galvanized process. Baked clear elastic enamel coating in and out. Use for installations in stud walls, masonry walls, above suspended ceilings and where exposed.
- E. Flexible Metal Conduit: Formed of one continuous length of spirally wound electro galvanized steel strip, UL listed. Use for final connections to all motor operated equipment such as unit heaters, fans, air handling units, pumps, generators, generator enclosures and connections to dry type transformer, connections from junction boxes to lighting fixtures in accessible ceiling, and for wiring within casework and millwork. 6' maximum length.

- F. Liquidtight Flexible Metal Conduit: Formed of one continuous length of spirally wound steel strip, with water and oil tight neoprene jacket, UL listed. Use for final connection to equipment listed in paragraph "E" above when located in wet areas.
- G. PVC Conduit: Conduit shall be Carlon PV Duit, Type 40, 90 deg.C. Conduit shall be composed of Polyvinyl Chloride and shall conform to NEMA Standards. Conduit, fittings and cement shall be produced by the same manufacturer. May be used where installed in earth fill or in poured concrete walls, columns, floors, or under concrete slab.
- H. Type MC Cable: Type MC cable meets or exceeds all applicable ASTM Specifications, UL Standard for Safety 1569, UL Standard for Safety 1581, UL Standard for Safety 83, Federal Specification A-A-59544 and requirements of the National Electrical Code (NFPA 70).
 - 1. Type MC cable is constructed with copper conductors that are soft annealed copper, insulated with heat and moisture resistant lead-free polyvinyl chloride (PVC) over which a nylon (polyamide) or UL listed equivalent jacket is applied (Type THHN and THWN). The assembly is wrapped with polypropylene tape and covered with interlocking aluminum armor.
 - 2. Cable shall be UL listed type MC, suitable for operation at 600 volts in all installations as specified by the National Electrical Code.
 - 3. MC cable shall contain a copper equipment ground conductor equal in size with the branch circuit conductors, with green insulation.
 - 4. MC CABLE ONLY TO BE USED FOR HHS LEVEL 3 TEMPORARY OFFICE FINISH ONLY. ALL TYPE MC CABLE IS TO BE REMOVED BY THE END OF CONSTRUCTION.
 - 5. Type MC cable is prohibited for feeders or branch circuits over 30 amps.
- I. Surface Metal Raceways: Provide surface metal raceways of sizes and channels indicated on plans and constructed of steel or aluminum with covers. Finish with manufacturer's standard baked on enamel paint or exposed metal as scheduled on drawings. Use where exposed in finished regularly occupied areas.
 - 1. Manufacturer: Subject to compliance with requirements, the following manufacturers are acceptable:
 - a. Wiremold (basis of design)
 - b. Hubbell

2.02 CONDUIT FITTINGS

- A. Rigid Conduit Fittings:
 - 1. Fittings shall be standard threaded couplings, locknuts, bushings, and elbows. Material shall be malleable iron, steel or aluminum alloy. Iron or steel fittings shall be zinc or cadmium plated. Aluminum fittings shall not contain more than 0.4 percent copper. Aluminum fittings shall be used with aluminum conduit only.
 - 2. Locknuts shall be of the bonding type with sharp edges for digging into the metal wall of an enclosure.
 - 3. Bushings shall be of the metallic insulating type and consist of an insulating insert molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
 - 4. Sealing fittings shall be of the threaded cast iron type. Sealing fittings used to prevent passage of water vapor shall be of the continuous drain type.
 - 5. Set screw fittings are not allowed.
- B. Metallic Tubing Fittings: Compression type galvanized or zinc coated malleable iron or steel, water and concrete tight where exposed to wet locations or imbedded in concrete. Steel set screw type acceptable in all dry location applications. Die-cast fittings are not allowed.
- C. Flexible Metal Conduit Fittings: External squeeze or set screw type galvanized or zinc coated malleable iron or steel with nylon insulated throats. Internal screw type fittings are not allowed.
- D. Liquidtight Flexible Conduit Fittings: Galvanized malleable iron or steel, with watertight gaskets, "O" ring and retainer, and nylon insulated throats.

- E. Condulet Fittings: Exposed conduit fittings shall be condulet type for all sharp turns, tees, etc.
- F. Surface Metal Raceway Fittings: Provide types that match and mate to raceways provided.
- G. Provide insulated bushings for all conduits terminations.

2.03 WALL OUTLET BOXES

- A. General: Boxes shall be Raco, Steel City, Appleton or equal, catalog numbers based on Raco, unless otherwise indicated. In general, the type of boxes shall be as follows:
 - 1. In Stud Walls: For single outlet use 4" square by 2-1/8" deep box. Boxes to be provided with raised covers of depth as required for thickness of wall materials.
 - 2. In Masonry and Poured Concrete Walls: Use 3 3/4" high by 2 1/2" and/or 3 1/2" deep masonry boxes #691 through #694 and/or #695 through #699.
 - 3. Surface Mounted Wall Outlets for conduit: Use 4" square by 1 1/2" deep box #192 with raised cover.
 - 4. Surface Mounted Wall Outlets for surface metal raceway: Use single gang boxes 1-1/2" deep Wiremold #V57xx series.
 - 5. Suspended Ceiling: Use octagon boxes, depth as required for application, securely fastened to structure.
 - 6. Poured Concrete Ceiling Slabs: Use octagon concrete rings with back plates.
 - 7. Outlets Installed Outdoors or in Wet Locations: Use Bell Product 53XX Series outlet box.

2.04 ACTIVATION BOXES

- A. Activation Boxes: Provide boxes as scheduled on the drawings.
- B. Activation boxes shall be provided with barriers to separate high and low potential voltages.
- C. Activation boxes shall be, complete with necessary gaskets, plates, spacers, mud caps, covers, fasteners, brackets and ancillary components appropriate for their installation. Follow manufacturer's specific written instructions for each type of installation.
- D. Furnish electrical outlets with duplex receptacles per specification Section 26 2726 – Wiring Devices.
- E. Manufacturers: Subject to compliance with requirements, the following manufacturers are acceptable:
 - 1. Wiremold/Legrand/Chief
 - 2. FSR Inc.
 - 3. Hubbell
 - 4. Steel City

2.05 PULL BOXES, AND JUNCTION BOXES

- A. Construction, sizes and installation of pull boxes and junction boxes shall comply with NEC, Article 314.
- B. Pull and junction boxes not specifically described in NEC, Article 314, shall be fabricated of heavy gauge galvanized steel with screw or hinged covers, and equipped with corrosion resistant screws and hardware.
- C. Pull and junction boxes for installation in poured concrete floors shall be flush type, cast iron, with watertight gasketed covers. Boxes for installation in floors with tile or carpet floor covering shall have recessed covers to accommodate the floor covering.
- D. Pull boxes and junction boxes for outdoor installation shall be raintight.
- E. Pull boxes, and junction boxes designated '4X' shall be NEMA 4X water tight and corrosion resistant.

2.06 METAL WIREWAYS

- A. Construction, sizes and installation metal wireways shall comply with NEC, Article 376.

- B. General: Provide electrical raceways of types, grades, sizes and weights (wall thicknesses), number of channels, for each type of gutter indicated. Provide complete assembly of raceway including, but not necessarily limited to, couplings, offsets, elbows, expansion joints, adapters, hold down straps, end caps, and other components and accessories as needed for complete system. Where types and grades are not indicated, provide proper selection as determined by Installer to fulfill wiring requirements, and comply with applicable provisions of NEC for electrical raceways.
- C. Wireways shall be constructed as a complete assembly of raceway including, but not necessarily limited to, couplings, offsets, elbows, expansion joints, adapters, hold down straps, end caps, and other components and accessories as needed for complete system. Gutters shall have hinged covers. Where types and grades are not indicated, provide proper selection as determined by Installer to fulfill wiring requirements.
- D. Wireways shall have hinged covers unless noted otherwise.
- E. Wireways for outdoor installation shall be raintight.
- F. Wireways designated '4X' shall be NEMA 4X watertight and corrosion resistant.

2.07 IN-GROUND HANDHOLES

- A. UL or ETL Listed, polymer concrete construction, open bottom stackable. Quazite PG style or equal.
 - 1. Manufacturer: Subject to compliance with requirements, the following manufacturers are acceptable:
 - a. Quazite
 - b. HiLine
 - c. Armorcast
 - d. New Basis
- B. All stainless steel hardware with minimum two fasteners per lid.
- C. Extra heavy duty covers with non-skid surface, tier 22, 22,500 lb. vertical and 800 lbs/sq. ft. lateral design loads, unless noted otherwise.
- D. Minimum size to be 11"x18", unless noted otherwise. Larger handholes may be required at select locations.

PART 3 - EXECUTION

3.01 INSTALLATION OF RACEWAY

- A. In general, all horizontal runs of branch circuit conduit shall be installed in ceiling plenum. Raceway for convenience outlets, wall mounted fixtures and other wall outlets shall be routed overhead and dropped through wall to the outlet.
- B. Branch circuit raceway shall not be installed in or below concrete floor slabs except where conditions will not permit the raceway to be installed overhead. Conduit shall be used where concealed in permanent wall construction or in ceiling plenums.
- C. Surface raceway shall be used where exposed in finished regularly occupied areas where walls are existing.
- D. Feeder conduits to panelboards, motor control centers and other major loads may be installed in fill below concrete slabs on grade.
- E. Conduits that are run in fill below concrete slabs on grade shall be installed so as not to interfere with welded wire mesh (wwm), vapor barrier, or concrete placement.
- F. Generally, all conduit shall be concealed, except in crawl spaces, tunnels, shafts, mechanical equipment rooms, and at connection to surface panels and free standing equipment, and as otherwise noted.
- G. Exposed conduit and conduit concealed in ceiling space shall be routed in lines parallel to building construction.

- H. All conduit runs above suspended acoustical ceilings shall be routed so as not to interfere with tile panel removals with 4'0" to 6'0" flexible conduit drops from an independent junction box, accessible from below the ceiling, to ceiling mounted equipment.
- I. Minimum size conduit shall be 3/4" trade size. Minimum size surface raceway shall be V700. Where specified size is not called for on drawings or in the specifications, conduit shall be sized per NEC.
- J. Utilize approved thread lubricant for rigid steel and aluminum conduits to ensure equipment grounding paths.
- K. Utilize approved thread sealant for all underground and wet locations threaded conduit joints.
- L. Install the conduit system mechanically and electrically continuous from outlet to outlet and to all cabinets, junction or pull boxes. Conduit shall enter and be secured to all cabinets and boxes in such a manner that all parts of the system will have electrical continuity.
- M. All conduit penetrations to the exterior of the building including the service entrance, telecommunications, site feeds, grounding electrode and spare conduits shall be sealed at one or both ends against the intrusion of water and gasses. The seal shall be identified for use with the cable insulation installed. All seals shall be removable.
- N. Installation of PVC conduit shall comply with the NEC with regard to grounding and expansion fittings.
- O. PVC conduit shall not be installed above grade unless noted otherwise.
- P. Support conduit raceway systems in accordance with requirements as set forth in the National Electric Code.
- Q. All connections to NEMA 3R enclosures shall maintain the enclosure listing regardless of the equipment location.
- R. Provide liquidtight flexible metal conduit for the last 3' of feeder/circuit for all vibration type equipment (i.e., motors, transformers, etc.).

3.02 INSTALLATION OF BOXES AND FITTINGS

- A. Install electrical boxes and fittings where indicated, complying with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. Coordinate installation of electrical boxes and fittings with wire/cable and raceway installation work.

3.03 OUTLET BOX INSTALLATION

- A. Outlet boxes shall be installed for all fixtures, switches, receptacles and other devices.
- B. Approximate locations of outlets are shown on the plans, but each outlet location as shown shall be checked by Contractor before installing the outlet box.
- C. Wall boxes installed flush in common wall shall not be back-to-back or through wall type. Boxes located on opposite sides of a common wall that are closely connected by conduit shall have the conduit openings plugged with duct seal.
- D. Install boxes and conduit bodies in those locations to ensure ready accessibility of electrical wiring.
- E. Outlet boxes shall be installed plumb and square with wall face and with front of box or cover located within 1/8" of face of finish wall. Boxes in masonry shall be set with bottom or top of the box tight to the masonry unit.

3.04 PULL BOX, JUNCTION BOX & WIREWAY INSTALLATION

- A. Install pull boxes, junction boxes and auxiliary wiring gutters where indicated on drawings and where required to facilitate installation of the wiring.

- B. For concealed conduit, install boxes flush with ceiling or wall, with covers accessible and easily removable. Where flush boxes are installed in finish ceilings or walls, provide cover which shall exceed the box face dimensions by a sufficient amount to allow no gap between box and finished material.
- C. Boxes shall not be located in finished, occupied rooms, without prior approval of Design Professional.

3.05 ACTIVATION BOX INSTALLATION

- A. Install activation boxes flush with surrounding wall or floor surface, factor in lids and covers in addition to wall/floor finishes when setting boxes.
- B. Coordinate raceway into boxes with Telecom and AV Contractors to limit number of bends and entry into appropriate sides of boxes.
- C. Coordinate exact placement of boxes with Architectural details, do not scale drawings for locations.

3.06 IN-GROUND HANDHOLE INSTALLATION

- A. Install all handholes flush with surrounding grade. Adjust handholes as required for finished grade.
- B. Do not install handholes at low grade points. Install at locations to allow drainage away from box.
- C. Provide 1" clean compacted fill beneath handholes for drainage. Clean fill shall extend 8" beyond the sides of the handhole enclosure, and a minimum of 12" deep.

END OF SECTION 26 05 33

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 00 10 - Electrical General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

- A. Contractor shall provide identification for wiring systems and equipment as called for in this section.
- B. Types of electrical identification specified in this section include the following:
1. Conduit color banding.
 2. Buried cable warnings.
 3. Cable conductor identification.
 4. Operational instructions and warnings.
 5. Danger signs.
 6. Equipment/system identification signs.

1.03 QUALITY ASSURANCE

- A. UL Compliance: Comply with applicable portions of UL safety standards pertaining to electrical marking and labeling identification systems.
- B. NEC Compliance: Comply with NEC as applicable to installation of identifying labels and markers for wiring and equipment.

PART 2 - PRODUCTS

2.01 ELECTRICAL IDENTIFICATION MATERIALS

- A. General: Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is Installer's option, but provide single selection for each application.
- B. Color Coded Conduit System
1. General: Provide manufacturer's standard colored conduit for EMT installations as noted below. For rigid aluminum, rigid steel, and IMC conduit, use colored electrical tape to band conduits within 6" of termination at each switchboard, panelboard, distribution board, pull box and junction box. Where conduit is exposed and painted to match adjacent surfaces, band with colored electrical tape.
 2. Colors:
 - a. Normal Power: gray/silver (uncolored)
 - b. Emergency: yellow*
 - c. Fire alarm: red*
 - d. Division 27 systems: purple**
 - e. Division 28 systems excluding fire alarm: purple**
 3. For exposed conduits in finished spaces, refer to architectural for paint to match room finish.
 4. For branch circuits, mark panel name and circuit numbers on all junction/pull boxes.
- * Factory colored conduit required for EMT conduit
** Field applied electrical tape banding at conduit terminations required. Factory colored conduit optional for EMT conduit.

- C. Underground Type Plastic Line Marker
 - 1. General: Manufacturer's standard permanent, bright colored, continuous printed plastic tape; not less than 6" wide x 4 mils thick intended for underground service. Provide tape with printing which most accurately indicates type of service of buried cable/conduit.
- D. Cable/Conductor Identification Bands
 - 1. General: Provide manufacturer's standard vinyl cloth self-adhesive cable/conductor markers of wrap around type; either pre numbered plastic-coated type or write on type with clear plastic self-adhesive cover flap; numbered to show circuit identification.
- E. Self-Adhesive Tape for Receptacle Circuit Identification
 - 1. General: Provide clear self-adhesive or pressure sensitive, preprinted, flexible vinyl tape for panel name and circuit number.
- F. Engraved Plastic Laminate Signs
 - 1. General: Provide engraving stock melamine plastic laminate, in sizes and thickness indicated, engraved with engraver's standard letter style of sizes and wording indicated, black and white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
 - a. Thickness: 1/16", for units up to 20 sq. in. or 8" lengths; 1/8" for larger units.
 - b. Fasteners: Self tapping stainless steel screws, except contact type permanent adhesive where screws cannot or should not penetrate substrate.

PART 3 - EXECUTION

3.01 APPLICATION AND INSTALLATION

- A. General Installation Requirements
 - 1. Coordination: Where identification is to be applied to surfaces which require finish, install identification after completion of painting.
- B. Conduit Identification
 - 1. Conduit above accessible ceiling spaces shall be identified per 2.01 B.
 - 2. Where electrical conduit is exposed in spaces with exposed mechanical piping which is identified by a color coded method, apply color coded identification on electrical conduit in a manner similar to piping identification.
 - 3. Identify junction and pullboxes of systems with stencil lettering for panel and circuit numbers or system type.
- C. Underground Cable/Conduit Identification
 - 1. General: During back filling/top/soiling of each exterior underground electrical, signal or communication cable or conduit, install continuous underground type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in a common trench and do not exceed an overall width of 16", install a single line marker.
- D. Cable/Conductor Identification
 - 1. General: Apply cable/conductor identification on each cable and conductor in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present, except where another form of identification (such as color-coded conductors) is provided. Match identification with marking system used in panelboards, shop drawings, contract documents and similar previously established identification for project electrical work.
- E. Operational Identification and Warnings
 - 1. General: Wherever reasonably required to ensure safe and efficient operation and maintenance of electrical systems, and electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical facilities by unauthorized personnel, install self-adhesive plastic signs or similar equivalent identification, instruction or warnings on switches, outlets and other controls, devices and covers of electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for intended purposes.

F. Equipment/System Identification

1. General: Install engraved plastic laminate sign on each major unit of electrical equipment in building; including central or master unit of each electrical system, unless unit is specified with its own self-explanatory identification. Except as otherwise indicated, provide single line of text, 1/2" high lettering on 1 1/2" high sign (2" high where 2 lines are required), white lettering in black field. Provide text matching terminology and numbering of the contract documents and shop drawings. Provide signs for each unit of the following categories of electrical work.
 - a. Panelboards, electrical cabinets and enclosures.
 - b. Access panel/doors to electrical facilities.
 - c. Major electrical switchgear.
 - d. Motor control centers, disconnects & starters.
 - e. Power transfer equipment.
 - f. Transformers.
 - g. Inverters.
 - h. Generators.
2. Install signs at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with fasteners, except use adhesive where fasteners should not or cannot penetrate the substrate.
3. Provide labeling of Enclosed Circuit Breakers, Switchboards, Panelboards and Disconnects per NEC Articles 110, 700 and 702 for multiple services and essential electrical system.
4. All receptacles and light fixtures shall be labeled with panel and circuit number. Final location of label shall be field coordinated. If labeling is to be on outside of cover, Contractor shall use clear dyno-tape with black lettering that matches other tags.
5. All panelboards shall be labeled with panel ID, conduit size, feeder wire size, origin and size of overcurrent protection device serving panelboard and phase schedule. Format shall be as follows:

"Panel XX, 1.25"C, 4#3, 1#8, Fed from Dist. Bd. XX by 100A/3P
Phase A: Black, Phase B: Red, Phase C: Blue"
6. All new switchboards and panelboards shall be labeled (5/32" or larger) with the following:

"Caution – This equipment has a minimum short circuit design requirement of ___KA. All devices installed must have a rating equal or higher than the design requirement."
7. All safety switches shall have a permanent label attached to inside of cover describing the fuse size, type, current limiting ability and devices controlled.

END OF SECTION 26 05 53

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SECTION 26 05 73

SHORT-CIRCUIT/COORDINATION STUDY/ARC FLASH HAZARD ANALYSIS

PART 1 - GENERAL

1.01 SCOPE

- A. The contractor shall furnish short-circuit, protective device coordination studies and arc flash analysis which shall be prepared by the equipment manufacturer.
- B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

1.02 DESCRIPTION OF WORK

- A. Provide separate short circuit/arc flash hazard analysis for the following buildings:
 - 1. Administration (ADM) Building
 - 2. Health and Human Service (HHS) Building
- B. The study shall include and existing, modified and new components of the electrical distribution system.

1.03 REFERENCES

- A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - 1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
 - 2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
 - 3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis
 - 4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings
 - 5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems
 - 6. IEEE 1584 – Guide for Performing Arc-Flash Hazard Calculations
- B. American National Standards Institute (ANSI):
 - 1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
 - 2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
 - 3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
 - 4. ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories
 - 5. ANSI C37.5 – Methods for Determining the RMS Value of a Sinusoidal Current Wave and Normal-Frequency Recovery Voltage, and for Simplified Calculation of Fault Currents
- C. The National Fire Protection Association (NFPA)
 - 1. NFPA 70 - National Electrical Code, latest edition
 - 2. NFPA 70E – Standard for Electrical Safety in the Workplace
 - 3. Submittals for review/approval
- D. The short-circuit and protective device coordination studies shall be submitted to the Design Professional prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the Design Professional may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.

1.04 SUBMITTALS FOR CONSTRUCTION

- A. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. No more than five (5) bound copies of the complete final report shall be submitted. For large system studies, submittals requiring more than five (5) copies of the report will be provided without the section containing the computer printout of the short-circuit input and output data. Additional copies, where required, shall be provided on CD in PDF format.
- B. A preview of the report shall be submitted to the Design Professional indicating short circuit calculations and arc flash levels prior to any electrical gear being released.
- C. The report shall include the following sections:
 - 1. One-line diagram showing protective device ampere ratings and associated designations, cable size & lengths, transformer kVA & voltage ratings, motor & generator kVA ratings, and switchgear/switchboard/panelboard designations
 - 2. Descriptions, purpose, basis and scope of the study
 - 3. Tabulations of the worst-case calculated short circuit duties as a percentage of the applied device rating (automatic transfer switches, circuit breakers, fuses, etc.); the short circuit duties shall be upward-adjusted for X/R ratios that are above the device design ratings
 - 4. Protective device time versus current coordination curves with associated one line diagram identifying the plotted devices, tabulations of ANSI protective relay functions and adjustable circuit breaker trip unit settings
 - 5. Fault study input data, case descriptions, and current calculations including a definition of terms and guide for interpretation of the computer printout
 - 6. Incident energy and flash protection boundary calculations
 - 7. Comments and recommendations for system improvements, where needed
 - 8. Executive Summary including source of information and assumptions made

1.05 QUALIFICATIONS

- A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies. The Registered Professional Electrical Engineer shall be a full-time employee of the Engineering Services Organization.

PART 2 - PRODUCTS

2.01 STUDIES

- A. Contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer. By using the equipment manufacturer, the study allows coordination of proper breakers, fuses, and current transformers. The coordination study shall begin with the utility company's feeder protective device and include all of the electrical protective devices down to and include the largest feeder circuit breaker and motor starter in the motor control centers and power distribution panelboards. The study shall also include variable frequency drives, harmonic filters, power factor correction equipment, transformers and protective devices associated with variable frequency drives, emergency and standby generators associated paralleling equipment and distribution switchgear.
- B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

2.02 DATA COLLECTION

- A. Contractor shall furnish all field data as required by the power system studies. The Design Professional performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to eliminate unnecessary delays and assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

- B. Source combination may include present and future utility supplies, motors, and generators.
- C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner or Contractor.
- D. Include fault contribution of existing motors in the study, with motors < 50 hp grouped together. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.
- E. All buildings include existing electrical equipment and feeders. Contractor shall gather all information on the existing distribution system for inclusion in the studies. Information to be gathered includes, but is not limited to:
 - 1. Feeder Configuration
 - 2. Feeder Length
 - 3. OCPD manufacturers and models
 - 4. Existing equipment interrupt ratings.

2.03 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

- A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standards 141, latest edition.
- B. Transformer design impedances and standard X/R ratios shall be used when test values are not available.
- C. Provide the following:
 - 1. Calculation methods and assumptions
 - 2. Selected base per unit quantities
 - 3. One-line diagram of the system being evaluated with available fault at each bus, and interrupting rating of devices noted
 - 4. Source impedance data, including electric utility system and motor fault contribution characteristics
 - 5. Typical calculations
 - 6. Tabulations of calculated quantities
 - 7. Results, conclusions, and recommendations
- D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:
 - 1. Electric utility's supply termination point
 - 2. Incoming switchgear
 - 3. Unit substation primary and secondary terminals
 - 4. Low voltage switchgear
 - 5. Motor control centers
 - 6. Standby generators and automatic transfer switches
 - 7. Branch circuit panelboards
 - 8. Other significant locations throughout the system
- E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.
- F. Protective Device Evaluation:
 - 1. Evaluate equipment and protective devices and compare to short circuit ratings
 - 2. Adequacy of switchgear, motor control centers, and panelboard bus bracing to withstand short-circuit stresses
 - 3. Adequacy of transformer windings to withstand short-circuit stresses
 - 4. Cable and busway sizes for ability to withstand short-circuit heating
 - 5. Notify Owner in writing, of existing, circuit protective devices improperly rated for the calculated available fault current
- G. In such cases where the short circuit study results in a requirement for greater AIC ratings than those listed in the contract documents, contact the design engineer for possible solutions. Current limiting fusible technology may be added to the electrical system to limit the amount of available fault current. The manufacturer providing the short circuit calculation shall recognize current limiting fusible technology and re-run the short circuit calculations.

2.04 PROTECTIVE DEVICE COORDINATION STUDY

- A. Proposed protective device coordination time-current curves shall be graphically displayed on log-log scale paper.
- B. Include on each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered.
- C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.
- D. Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
- E. Plot the following characteristics on the curve sheets, where applicable:
 - 1. Electric utility's protective device
 - 2. Medium voltage equipment relays
 - 3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
 - 4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
 - 5. Transformer full-load current, magnetizing inrush current, and ANSI transformer withstand parameters
 - 6. Conductor damage curves
 - 7. Ground fault protective devices, as applicable
 - 8. Pertinent motor starting characteristics and motor damage points
 - 9. Pertinent generator short-circuit decrement curve and generator damage point
 - 10. Other system load protective devices for the largest branch circuit and the largest feeder circuit breaker in each motor control center
- F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.05 ARC FLASH HAZARD ANALYSIS

- A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2018.
- B. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Alternative methods shall be presented in the proposal.
- C. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.
- D. The Arc-Flash Hazard Analysis shall include all MV, 480v, 240V and 208V locations.
- E. Safe working distances shall be specified for calculated fault locations based upon the calculated arc flash boundary considering an incident energy of 8 cal/cm². Where values of greater than 8 calories per centimeter exist, advise Engineer on options for reduction of energy that exceed the contractual requirements.
- F. The Arc Flash Hazard analysis shall include calculations for maximum and minimum contributions of fault current magnitude. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume a minimum motor load. Conversely, the maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
- G. Arc flash computation shall include both line and load side of main breaker calculations, where necessary.
- H. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2018.

2.06 REPORT SECTIONS

- A. Input Data:
 - 1. Utility three-phase and line-to-ground available contribution with associated X/R ratios
 - 2. Short-circuit reactance of rotating machines with associated X/R ratios
 - 3. Cable type, construction, size, # per phase, length, impedance and conduit type
 - 4. Bus duct type, size, length, and impedance
 - 5. Transformer primary & secondary voltages, winding configurations, kVA rating, impedance, and X/R ratio
 - 6. Reactor inductance and continuous ampere rating
 - 7. Aerial line type, construction, conductor spacing, size, # per phase, and length
- B. Short-Circuit Data:
 - 1. Source fault impedance and generator contributions
 - 2. X to R ratios
 - 3. Asymmetry factors
 - 4. Motor contributions
 - 5. Short circuit kVA
 - 6. Symmetrical and asymmetrical fault currents
- C. Recommended Protective Device Settings:
 - 1. Phase and Ground Relays:
 - a. Current transformer ratio.
 - b. Current setting.
 - c. Time setting.
 - d. Instantaneous setting.
 - e. Specialty non-overcurrent device settings.
 - f. Recommendations on improved relaying systems, if applicable.
 - 2. Circuit Breakers:
 - a. Adjustable pickups and time delays (long time, short time, ground).
 - b. Adjustable time-current characteristic.
 - c. Adjustable instantaneous pickup.
 - d. Recommendations on improved trip systems, if applicable.
- D. Incident energy and flash protection boundary calculations.
 - 1. Arcing fault magnitude
 - 2. Device clearing time
 - 3. Duration of arc
 - 4. Arc flash boundary
 - 5. Working distance
 - 6. Incident energy
 - 7. Hazard Risk Category
 - 8. Recommendations for arc flash energy reduction

PART 3 - EXECUTION

3.01 FIELD ADJUSTMENT

- A. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the Contractor.
- B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.
- C. Notify Owner in writing of any required major equipment modifications.

3.02 ARC FLASH WARNING LABELS

- A. The vendor shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.

- B. The label shall have an orange header with the wording, "WARNING, ARC FLASH HAZARD", and shall include the following information:
 - 1. Location designation
 - 2. Nominal voltage
 - 3. Flash protection boundary
 - 4. Hazard risk category
 - 5. Incident energy
 - 6. Working distance
 - 7. Engineering report number, revision number and issue date
- C. Labels shall be machine printed, with no field markings
- D. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
 - 1. For each 600, 480 and applicable 208 volt panelboards and disconnects, one arc flash label shall be provided
 - 2. For each motor control center, one arc flash label shall be provided
 - 3. For each low voltage switchboard, one arc flash label shall be provided
 - 4. For each switchgear, one flash label shall be provided
 - 5. For medium voltage switches one arc flash label shall be provided
- E. Labels shall be field installed by the Contractor.

END OF SECTION 26 05 73

**SECTION 26 09 23
LIGHTING CONTROL SYSTEMS**

PART 1 - GENERAL

1.01 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 00 10 - Electrical General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

- A. Provide materials, equipment, labor and supervision necessary for a complete operational lighting control system as required by the drawings and this section.
- B. This section includes lighting control system for three separate buildings:
 - 1. Administration (ADM) Building – New system
 - 2. Ambulance and Medical Examiner (AME) Building- Extension of existing Hubbell system
 - 3. Health and human Services (HHS) Building – New system
- C.
- D. This section applies to all work under this division. This shall include, but not necessarily be limited to, the following:
 - 1. Furnish, install, and terminate all system equipment and cabling as applicable and per drawings for a wired control system. No wireless control components.
 - 2. Furnish and install any cabinets, racks and cable management as required and as indicated.
 - 3. Furnish any other material required to form a complete and operational system.
 - 4. Provide As-Built drawings per Division 0 and/or Division 1 specification.
 - 5. Provide Owner training and testing documentation.
 - 6. All elements of the construction shall be performed by workmen skilled in the particular craft involved, and regularly employed in that particular craft.
 - 7. All work shall be performed in a neat, workmanlike manner in keeping with the highest standards of the craft.

1.03 QUALITY ASSURANCE

- A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wiring devices.
- B. UL Compliance and Labeling: Provide electrical wiring devices which have been UL listed and labeled.
- C. NEMA Compliance: Comply with NEMA standards for general and specific purpose wiring devices.
- D. ASHRAE Compliance: Comply with ASHRAE 90.1-2010 section 9.
- E. All Contractors shall familiarize themselves with all codes and standards applicable to their work. No extra compensation will be allowed for corrections or changes in the work required due to failure to comply with the applicable codes and standards. Where two or more codes or standards are in conflict, that requiring the highest order of workmanship shall take precedence, but such questions shall be referred to Design Professional for final decision.

1.04 SUBMITTALS

- A. Submit manufacturer's product data literature for each lighting control component required. For occupancy sensors and related components, submit Manufacturer's device layout indicating recommended device placement, product data and project specific wiring diagrams. Submittals shall include the Sequence of Operation for each area of lighting control

1.05 WARRANTY

- A. The control system designated on the drawings and plans and herein specified shall be guaranteed to be free from original defects in both material and workmanship for a period of five (5) years. This warranty shall become effective starting the date of project substantial completion.

1.06 SYSTEM DESCRIPTION

- A. System Architecture:
 - 1. The lighting control system shall be a networked lighting control system with centralized timing, control and programming functions.
 - 2. All system adjustments for time delays, high-level trim, low-level trim, fade times, blink warnings, photo sensor sensitivity, daylight setpoints, receptacle control time delays, vacancy mode, occupancy mode, etc. shall be programmable and adjustable without the use of a ladder.
- B. Lighting control system for manual and automatic control of interior lighting systems.
 - 1. Space Control – Provide occupancy/vacancy control with manual occupant input as noted on the lighting control sequence schedule.
 - 2. Daylit Areas – All luminaires in the daylit zone shall be controlled separately from luminaires outside of daylit zones. Luminaires in the primary daylit zones shall be controlled separately from luminaires in secondary daylit zones.
 - 3. Daytime setpoints for total ambient illumination (combined daylight and electric light) level that initiate dimming shall be programmed to be not less than 125% of the nighttime maintained designed illumination levels.
 - 4. Provide smooth and continuous daylight dimming for areas marked on drawings. Daylighting control system will be designed to turn off electric lighting when daylight is at or above required lighting levels, only if system functions to turn fixtures back on at dimmed level, rather than turning full-on prior to dimming.
 - 5. Provide smooth and continuous automatic and/or manual color tuning for areas noted in the lighting control sequence.
- C. Additional controls.
 - 1. Provide 20A rated relays for control of receptacle loads as indicated on the drawings. Receptacle load relays are to operate whenever occupancy is detected regardless of manual switch input or photosensor input. Refer to the power plans for the quantity of circuits to be controlled in each space.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide lighting control systems of one of the following:
 - 1. WattStopper Digital Lighting Management – DLM
 - 2. Hubbell Building Automation – NX
 - 3. Leviton – SectorFlex
 - 4. Cooper Greengate
 - 5. Acuity Controls – nLight

2.02 LINE VOLTAGE SINGLE / DUAL RELAY WALL SWITCH OCCUPANCY SENSORS (STAND-ALONE)

- A. Dual Technology: Manual-ON, Automatic-OFF dual technology (passive infrared and ultrasonic) wall switch occupancy sensor. 0-10V dimmable where noted. Two zone where noted. Furnish the model which suits the electrical system parameters, and accommodates the square-foot coverage and wattage requirement for each area (and type of lighting) controlled. 120/277VAC rated.

2.03 WALL OR CEILING MOUNTED OCCUPANCY SENSOR

- A. Description: Wall or ceiling mounted passive infrared (PIR), ultrasonic/microphonic, or dual technology occupancy sensor. Furnish the system which accommodates the square-foot coverage requirements for each area controlled, utilizing room controllers, occupancy sensors and accessories which suit the lighting and electrical system parameters.
- B. Specific sensors shall be selected based on the mounting height and device placement indicated as well as the performance characteristics of the manufacturer's proposed sensor. Where the manufacturer determines the controlled space exceeds the sensing range of the available sensors, additional sensors shall be included.
- C. Sensor shall be compatible with the environment installed.
 - 1. Indoor sensors in controlled environments shall be rated for use rated for use from 0 degrees C to 40 degrees C.
 - 2. Outdoor sensors shall be NEMA 3R or 4X, rated for use from -40 degrees C to 65 degrees C.
 - 3. Sensors in specialty areas (freezers, hose-down areas, etc.) shall be selected for the specific application.

2.04 LIGHTING CONTROL STATION

- A. Description: Low voltage control station in multi-button configuration compatible with wall plates with decorator opening. Control stations shall include the following features:
 - 1. Engraving where indicated on the drawings.
 - 2. LED Pilot Lights: Required where indicated on Drawings.
- B. Control stations shall be able to function as noted below:
 - 1. Load and Scene button function may be reconfigured for individual buttons.
 - 2. Individual button function may be configured to Toggle, On only, Off only, Raise or Lower.
 - 3. Individual scenes may be locked to prevent unauthorized change.

2.05 ROOM CONTROLLERS

- A. Room Controllers shall be provided to match the room lighting load and control requirements. The control units will include the following features:
 - 1. Dual voltage (120/277 VAC, 60 Hz)
- B. On/Off Room Controllers shall include:
 - 1. One or more relay configuration
 - 2. Relay controller listed for connection to receptacles, for occupancy-based control of plug loads within the space.
 - a. One relay configuration only, rated at 20A, 120VAC.
 - b. Automatic-ON/OFF configuration
- C. On/Off/Dimming Room Controllers shall include:
 - 1. One or more relay configuration
 - 2. One 0-10 volt analog output per relay for control of compatible ballasts and LED drivers.
 - 3. The following dimming attributes may be changed or selected via programming:
 - a. Establish preset level for each load from 0-100%
 - b. Set high and low trim for each load

2.06 RECEPTACLE CONTROL RELAYS

- A. Receptacle control relays shall be provided to match the room receptacle load requirements. The relays shall include the following features:
 - 1. 120VAC, 60 Hz relay
 - 2. 20A rated.
 - 3. Relay shall be listed for connection to receptacles, for occupancy-based control of plug loads within the space.
 - a. Automatic-ON/OFF configuration based on room occupancy only. User input at lighting controls station or photosensors shall not control receptacle relays.

- b. Examine power drawings to determine the quantity of receptacle control relays required.

2.07 PHOTOSENSORS

- A. Photosensors work with room controllers to provide automatic switching or dimming daylight harvesting capabilities for any load type connected to a room controller. Closed loop photosensors measure the ambient light in the space and control a single lighting zone. Open loop photosensors measure incoming daylight in the space.

2.08 RELAY PANELS

- A. Provide lighting control panels in the locations and capacities as indicated on the plans and schedules. Each panel shall be of modular construction and consist of the following components:
 1. Enclosure/Tub shall be NEMA 1, or as indicated on the plans.
 2. Cover shall be configured for surface or flush wall mounting of the panel as indicated on the plans. The panel cover shall have a hinged and lockable door with restricted access to line voltage section of the panel.
 3. Interior assembly shall be supplied as a factory assembled component specifically designed and listed for field installation. The interior construction shall provide total isolation of high voltage (Class 1) wiring from low voltage (Class 2) wiring within the assembled panel. The interior assembly shall include intelligence boards, power supply, and individually replaceable latching type relays. The panel interiors shall include the following features:
 - a. Single-pole latching relays with modular plug-in design. Relays shall provide the following ratings and features:
 - 1) Electrical:
 - a) 30 amp ballast at 277V
 - b) 20 amp tungsten at 120V
 - c) 1.5 HP motor at 120V
 4. The clock shall have a backlight display, user keypad and shall provide 8 channels of time or astronomical control. Preprogrammed lighting control scenarios shall include: scheduled on/off, manual on/scheduled off, manual on/automatic switch sweep off, astronomic or photocell on/off and astronomic or photocell control with scheduled on/off. Time clock shall provide up to 42 holidays, automatic daylight savings adjustment, astronomic coordinates by major cities, and help screens. Program memory shall be non-volatile and clock shall retain time keeping during power outages for at least 48 hours.
 5. Occupancy sensor and time control shall be integrated to allow occupancy sensor control after hours with hold on of lighting during occupancy scheduled time. During occupied time, control scenarios shall be selectable for time schedule of lighting on or occupancy sensor detection of lighting on initially and then hold on of lighting during occupied hours. Control shall provide selectable occupancy sensor blink warning prior to shut off and adjustable occupancy sensor time delay from the time clock keypad.
 6. After-hour interior lighting shut off control shall provide a full duration override time of 1 to 240 minutes with a warning blink five minutes prior to shutting the lighting off. An impending shut off will be cancelled and the override period re-initialized through the operation of any assigned switch input.
 7. After-hour interior lighting shut off control may be by line voltage power interrupt control to automatic control switches. The lighting control relay panel shall provide a warning blink signal to automatic control switches, thus allowing a five-minute delay prior to shutting off lighting. The lighting shut off event may be cancelled by pressing the automatic control switch push button. The lighting control panel time clock shall provide periodic lighting sweep signals to shut off automatic control switches.
 8. UL924 emergency operation that drives any emergency powered fixtures to 100% output during a normal power loss. Emergency circuits shall be behind a physical barrier and separated from normal power circuits.

- B. Power supply shall be a multi-voltage transformer assembly with rated power to supply all electronics, occupancy sensors, switches, pilot lights, and photocells as necessary to meet the project requirements.

2.09 EMERGENCY LIGHTING – AUTOMATIC LOAD CONTROL RELAY (ALCR)

- A. Emergency Lighting Control Unit – A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure, the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:
 - 1. 120/277 volts, 50/60 Hz. 20 amp rating
 - 2. Push to test button
 - 3. Auxiliary contact for remote test or fire alarm system interface
 - 4. Relays controlling 0-10V dimmed emergency lights shall include an auxiliary or integral relay device to open the control signal and force emergency lights to 100% light output.

2.10 CONTROLLED EMERGENCY LIGHTING IN LOCATIONS WITH ONLY EMERGENCY POWER (e.g., STAIRWELLS) – BRANCH CIRCUIT EMERGENCY LIGHTING TRANSFER SWITCH (BCELTs)

- A. Emergency Lighting Control Unit – A UL 1008 listed device that receives a switched/dimmed circuit providing normal lighting to an area and an unswitched/uncontrolled emergency circuit. The unit is wired to the other normal power lighting circuit in the area for ON/OFF/Dim control. Upon normal power failure, the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:
 - 1. 120/277 volts, 50/60 Hz. 20 amp rating
 - 2. Push to test button
 - 3. Auxiliary contact for remote test or fire alarm system interface

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install components as indicated on the drawings and as called for below.
- B. Low-voltage lighting control cables shall not share raceway or cable tray with telecommunications wiring. All cable shall be neatly routed and tie-wrapped to structural components. Excess wire shall be neatly coiled and secured to structure. Under no circumstances shall cable be supported by piping, conduit, ductwork, ceiling tile, or ceiling support wires. Cable shall be neatly routed in line with building lines.
- C. Provide a 8' coil of cable at each ceiling mounted device for ease of relocation if conflicts arise.
- D. Where concealed in walls or ceilings, lighting control cable shall be installed in conduit. Refer to 26 05 22 - Raceways and Boxes for Electrical Systems.
- E. All low-voltage lighting control cables shall be plenum rated.
- F. Where devices are installed in finished locations without ceilings, lighting control cables shall be installed in conduit.
- G. Where installed above accessible ceiling, all components shall be located in easily accessible areas. Any controller located in an area above a non-removable ceiling tile or where obstructed by piping or duct work shall be relocated. All locations shall be recorded on as-built drawings.
- H. Low voltage lighting control cable shall not use the same conduit sleeves as fire alarm or telecommunications cable. Provide dedicated sleeves. Where installed within non-accessible permanent construction or in exposed areas, provide continuous raceway to accessible location.
- I. It is the Contractor's responsibility to determine the ceiling type for each space and provide accessories as required for installation of devices in ceiling.
- J. Proper judgment must be exercised in executing the installation so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components.

- K. It is the Contractor's responsibility to arrange a pre-installation meeting with the manufacturer's factory authorized representative at the Owner's facility to verify placement of sensors and installation criteria.
- L. Install the work of this Section in accordance with manufacturer's printed instructions unless otherwise indicated.
- M. Contractor is responsible to arrange a coordination meeting with the Division 23 Building Automation System contractor to coordinate BACnet or dry contact interface of the systems.
- N. Occupancy Sensors shall be installed in accordance with manufacturer's instructions.
 - 1. Where devices are directional, devices shall be placed to sense occupancy of the area controlled by the device.
- O. Photosensors shall be installed in accordance with the manufacturer's requirements.
 - 1. Open loop sensors shall be placed to sense only the natural light entering the space with no artificial light component.
 - 2. Closed loop sensors shall be placed within the zone of controlled light. Closed loop sensors shall be placed and oriented to sense the light level on the work plane. Do not located where the sensor is blocked or illuminated by suspended light fixtures or other objects within the space.
- P. Calibrate all sensor time delays and sensitivity to provide proper detection of occupants and energy savings.
 - 1. Adjust time delay so that controlled area remains lighted for 15 minutes after occupant leaves area or as indicated in the Sequence of Operations.
 - 2. Adjust lighting system to provide maximum lighting levels as indicated on the drawings.
- Q. Provide 120V or 277V circuits as required for lighting control components.
- R. Provide network information jacks as required for lighting control system.
- S. Install emergency lighting control units (ELCU) in accordance with manufacturer's requirements.
 - 1. ELCU shall be located in an accessible location to allow access to the test button. Where ELCU is not accessible from an 8' step ladder, install remote test button.

3.02 FACTORY COMMISSIONING

- A. Upon completion of each phase of the lighting control(s) installation, the lighting control system (all sensors and control equipment) shall be completely commissioned by the manufacturer's factory authorized technician who will verify all adjustments and sensor placement to ensure a trouble-free occupancy-based lighting control system. The electrical contractor shall modify sensor locations and wiring as directed by the factory technician as required to achieve required functionality.
- B. Upon completion of the lighting control system fine tuning the factory authorized technician shall provide the proper training to the Owner's personnel in the adjustment and maintenance of the sensors.
- C. Re-commissioning. After 90 days from Owner occupancy, review system performance with the Owner and recalibrate all sensor time delays and sensitivities to meet the Owner's requirements. Provide a detailed report of re-commissioning activity.
- D. Provide written or computer-generated documentation on the commissioning of the system including room by room description. Report to include:
 - 1. Sensor parameters, time delays, sensitivities, and daylighting setpoints.
 - 2. Sequence of operation, (e.g., manual ON, Auto OFF. etc.)
 - 3. Load Parameters (e.g., blink warning, etc.)

3.03 TRAINING

- A. Provide three (3) two-hour training sessions for the Owner. The first training session is to be at the time of initial system startup. The second session is to be post-occupancy. The third session is to be used at Owner's discretion. The training is to include, but not limited to the following:
1. Detailed review of the system architecture, individual components, and wiring requirements.
 2. System programming method included examples and demonstrations. These are to include adjustments for time delays, high-level trim, low-level trim, fade times, blink warnings, receptacle control time delays, vacancy mode, occupancy mode, etc.
 3. Occupancy sensitivity adjustments for both PIR and ultrasonic setting, adjustments for an automatic learning mode and the ability to disconnect, and selection between PIR and Ultrasonic modes for dual technology devices.
 4. System troubleshooting including types of component failures, associated system failure and repair/replacement and reprogramming procedures.

3.04 SPARE PARTS

- A. Spare Parts: Provide the following list of spare equipment (for each type used) to Owner to match equipment used in project.
1. Occupancy Sensor– quantity: 2 of each type installed
 2. Room Controller, 2-zone 0 – 10V – quantity: 2
 3. Room Controller, one zone – quantity: 2
 4. Photosensor – quantity: 2 of each type installed.
 5. Control Cables – quantity: 100'
 6. Control Station, - Quantity: 2 of each type installed
 7. Any specialty tool required for programming - Quantity: 1

END OF SECTION 26 09 23

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**SECTION 26 22 00
LOW-VOLTAGE TRANSFORMERS**

PART 1 - GENERAL

1.01 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 00 10 - Electrical General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

- A. Contractor shall furnish all equipment, materials, tools, labor and supervision necessary to install transformers as specified in this section and as called for on the drawings.
 - 1. Dry-type Transformers.

1.03 QUALITY ASSURANCE

- A. NEC Compliance: Comply with NEC as applicable to installation and construction of electrical power/distribution transformers.
- B. NEMA Compliance: Comply with applicable portions of NEMA Std Pub Nos. TR 1 and TR 27 pertaining to power/distribution transformers.
- C. ANSI/IEEE Compliance: Comply with applicable ANSI/IEEE standards pertaining to power/distribution transformers.
- D. ANSI/NEMA Compliance: Comply with NEMA Std ST 20; "Dry Type Transformers for General Applications".
- E. UL Labels: Provide distribution transformers which have been UL listed and labeled.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data including rated KVA, frequency, primary and secondary voltages, percent taps, polarity, impedance and certification of transformer performance efficiency at indicated loads, percentage regulation at 100% and 80% power factor, no load and full load losses in watts, % impedance, hot spot and average temperature rise above 40 deg. C. ambient, sound level in decibels, and standard published data.
- B. Shop Drawings: Submit manufacturer's drawings indicating dimensions, and weight loadings for transformer installation.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products of one of the following (for each type of transformer):
 - 1. Schneider Electric/Square D (Basis of Design)
 - 2. ABB/GE Industrial Solutions
 - 3. Eaton
 - 4. Siemens

2.02 POWER/DISTRIBUTION TRANSFORMERS

- A. General: Except as otherwise indicated, provide manufacturer's standard materials and components as indicated by published product information, designed and constructed as recommended by manufacturer, and as required for complete installation.

- B. Dry Type Distribution Transformers: Provide factory assembled, general purpose, air cooled, dry type distribution transformers where shown; of sizes, characteristics, and rate capacities indicated. Provide primary windings with 6 taps; 2, 2 1/2% increments above full rated voltage and 4, 2 1/2% increments below full rated voltage for de energized tap changing operation. Limit transformer surface temperature rise to maximum of 65 deg.C. Provide terminal enclosure, with cover, to accommodate primary and secondary coil wiring connections. Insulation class of 220 deg. C, UL Component recognized insulation system. Limit terminal compartment temperature to 75 deg.C when transformer is operating continuously at rated load with ambient temperature of 40 deg.C. Cushion mount transformers with external vibration isolation supports; sound level ratings as determined in accordance with ANSI/NEMA standards. Electrically ground core and coils to transformer enclosure by means of flexible metal grounding strap. Provide transformers with fully enclosed sheet steel enclosures. Apply manufacturer's standard light gray indoor enamel over cleaned and phosphatized steel enclosure. Provide transformers suitable for wall mounting.

PART 3 - EXECUTION

3.01 INSTALLATION OF TRANSFORMERS

- A. Install transformers as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, ANSI and IEEE standards, and in accordance with recognized industry practices to ensure that products fulfill requirements.
- B. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
- C. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions.
- D. Coordinate transformer installation work with electrical raceway and wire/cable work, as necessary for proper interface.
- E. Install units on vibration mounts; comply with manufacturer's indicated installation method if any.
- F. Grounding: Provide equipment grounding connections, sufficiently tight to assure permanent and effective ground, for transformers as indicated.
- G. Transformers shall be connected to the raceway system with flexible conduit.
- H. Testing: Upon completion of installation of transformers, energize primary circuit at rated voltage and frequency from normal power source and test transformers, including, but not limited to, audible sound levels, to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.

END OF SECTION 26 22 00

**SECTION 26 24 16
PANELBOARDS**

PART 1 - GENERAL

1.01 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 00 10 - Electrical General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

- A. Contractor shall furnish all equipment, materials, tools, labor and supervision necessary to install lighting panelboards and distribution panelboards as specified in this section and as called for on the drawings.
- B. Types of panelboards and enclosures in this section include the following:
 - 1. Lighting and appliance panelboards.
 - 2. Power distribution panelboards.

1.03 QUALITY ASSURANCE

- A. Compliance: Comply with applicable UL safety standards pertaining to panelboards and accessories, and enclosures; provide units which have been UL listed and labeled.
- B. NEC Compliance: Comply with NEC as applicable to installation of panelboards, cabinets and cutout boxes.
- C. NEMA Compliance: Comply with NEMA Stds. Pub. No. 250, "Enclosures for Electrical Equipment (1000 volt maximum)", Pub. No. 1, "Panelboards", and installation portion of Pub. No. PB 1.1, "Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less".

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's data including specifications, installation instructions and general recommendations, for each type of panelboard required. Include data substantiating that units comply with requirements.
- B. Shop Drawings: Submit dimensioned drawings of panelboards and enclosures showing accurately scaled layouts of enclosures and required individual panelboard devices, including but not necessarily limited to, circuit breakers, fusible switches, fuses, ground fault circuit interrupters and accessories.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
 - 1. Schneider Electric/Square D (Basis of Design)
 - 2. ABB/GE Industrial Solutions
 - 3. Eaton
 - 4. Siemens

2.02 PANELBOARDS

- A. General: Except as otherwise indicated, provide panelboards, enclosures and components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials, design and construction in accordance with published product information; equip with number of unit panelboard devices as required for complete installation.
 - 1. All Multi-Section Panels: Same dimensions.
 - 2. Provide two keys for each panel.
 - 3. Provide copper ground bar.

4. All panels shall have a designed short circuit rating label.
- B. Lighting and Appliance Panelboards:
1. Panelboard bus structure and main lugs or main breakers shall have current ratings as shown on the panelboard schedule. Such ratings shall be established by heat rise tests, conducted in accordance with UL Standard 67. Bussing shall be distributed phase sequence type.
 2. The bus assembly shall be enclosed in a steel cabinet. Wiring gutter space shall be in accordance with UL Standard 67 for panelboards. The rigidity and gauge of steel to comply with UL Standard 50 cabinets. Provisions for additional circuit breakers shall be such that field addition to connectors or mounting hardware will not be required to add circuit breakers to the panelboards.
 3. If ground fault interrupting breakers (GFI), switched neutral or other special types of breakers require additional pole spaces, size of panel shall be increased accordingly to give the scheduled numbers of poles for spare breakers and blank spaces.
 4. Fronts shall include doors and have flush, stainless steel, cylinder tumbler type locks with catches and spring loaded door pulls. The flush lock shall not protrude beyond the front of the door. All panelboard locks shall be keyed alike. Fronts shall have adjustable indicating trim ring clamps which shall be completely concealed steel hinges. Fronts shall not be removable with door in the locked position. A circuitry directory frame and card with a clear plastic covering shall be provided on the inside of the door.
 5. Terminals for feeder conductors to the panelboard mains and neutral shall be UL listed as suitable for conductor specified.
 6. Each panelboard, as a complete unit, shall have a short circuit current rating equal to or greater than the integrated equipment rating shown on the panelboard schedule. Series connected interrupting ratings are not acceptable. This short circuit current rating shall be established by testing with the overcurrent devices mounted on the panelboard. The short circuit tests on the overcurrent devices and on the panelboard structure shall be made simultaneously by connecting the fault to each overcurrent device with the panelboard connected to its rated voltage source. Method of testing shall be per Underwriters Laboratories Standard UL 67. The source shall be capable of applying the specified panelboard short circuit current or greater. Testing of panelboard overcurrent devices for short circuit rating only while individually mounted is not acceptable. Also, testing of the bus structure by applying a fixed fault to the bus structure alone is not acceptable. Panelboards shall be marked with their maximum short circuit current rating at the supply voltage and shall be UL listed.
 7. Bus Bar: Copper.
 8. Provide two 1" C and three 3/4" C stubs out of all flush mounted panelboards to accessible ceiling space.
 9. Panelboards shall have door-in-door covers.
- C. Power Distribution Panelboards; Circuit Breaker Type:
1. Panelboards to be used for main circuit distribution and power circuit distribution shall be similar to lighting panelboards with the following additions:
 - a. Cabinet doors over 48" long shall be equipped with three point latch and vault lock. End walls shall be removable.
 - b. Main lugs or main breakers shall be barriered on five sides. The barrier in front of the main lugs shall be hinged to a fixed part of the interior. The end of the bus structure opposite the mains shall be barriered.
 - c. When required, panelboards shall be suitable for use as service equipment.
 - d. Bus Bar: Copper.

- D. Power Distribution Panelboards, fusible type:
1. Panelboards shall be dead front type, equipped with quick make, quick break fusible branch switches.
 - a. Panelboard bus structure and main lugs or main switch shall have current ratings as shown on the panelboard schedule. The bus structure shall accommodate plug on branch switches as indicated in the panelboard schedule without modifications to the bus assembly.
 - b. All fusible branch switches shall be quick make, quick break with visible blades and dual horsepower ratings. Switch handles shall physically indicate "ON" and "OFF" positions. Switches shall be lockable only in the "OFF" position and accept three industrial type heavy duty padlocks. Switch covers and handles shall be interlocked to prevent opening in the "ON" position. A means shall be provided to permit authorized personnel to release the interlock for inspection purposes. A circuit identification cardholder shall be provided for each branch switch.
 - c. Each panelboard, as a complete unit, shall have a short circuit current rating equal to or greater than the integrated equipment short circuit rating shown on the panelboard schedule or on the plans. Series connected interrupting ratings are not acceptable. This short circuit current rating shall be established by testing with the fusible switches mounted in the panelboard. Short circuit tests on the overcurrent devices and on the panelboard structure shall be made simultaneously by connecting the fault to each overcurrent device with the panelboard connected to its rated voltage source. Method of short circuit testing shall be per Underwriters Laboratories Standard UL 67. The source shall be capable of supplying the specified panelboard short circuit current or greater. Testing of panelboard overcurrent devices for short circuit rating only while individually mounted is not acceptable. Also, testing of the bus structure by applying a fixed fault to the bus structure alone is not acceptable. Panelboards shall be marked with their maximum short circuit rating at the supply voltage and shall be UL listed.
 - d. Panelboards shall be UL listed for use on a system capable of delivering not more than 200,000 rms symmetrical amperes at 600 volts ac maximum when all branch switches are equipped with appropriately rated Class R, J, L or T fuses.
 - e. Panelboard assembly shall be enclosed in a steel cabinet. The rigidity and gauge of steel to be as specified in UL Standard 50 for cabinets. Wiring gutters shall be sized in accordance with UL Standard 67. Cabinets shall be equipped with a four piece front without door and have concealed, self adjusting trim clamps. Fronts shall be of full finished steel with rust inhibiting primer and baked enamel finish.
 - f. Bus Bar: Copper.
- E. Load Centers:
1. Provide load center type panelboards as shown and scheduled on the drawings.
 2. Branch circuit breaker ratings shall be of size and number as indicated on drawings. Load centers shall be plug on type construction. All current carrying parts of the bus assembly shall be plated. Terminals for feeder conductors to main and branch neutral shall be UL listed as suitable for the type conductor specified. The load center bus assembly shall be enclosed in a steel cabinet. The size of the wiring gutters and gauge steel shall be in accordance with UL standards No. 67 for panelboards. Fronts shall include door and shall be provided with a directory for circuit identification. Load center boxes and fronts shall have rust resisting phosphate treatment and baked enamel finish.
 3. All branch breakers shall be plug on type, toggle action with quick make, quick break mechanism. Trip indication shall be clearly shown by the breaker handle taking a position between ON and OFF when the breaker is tripped. All multi pole breakers shall be single operating handle, common trip variety.
 4. Integrated Interrupting Rating: Series rating not allowed.

2.03 CIRCUIT BREAKERS

- A. General: Except as otherwise indicated, provide circuit breakers and ancillary components, of types, sizes, ratings and electrical characteristics indicated, which comply with manufacturer's standard design, materials, components, and construction in accordance with published product information, and as required for a complete installation.
- B. Circuit Breakers - Branch Circuit Panelboards:
 - 1. Branch circuit breakers up to 150 amperes shall be Square D Type QOB or equal. Breakers shall be bolt-on type toggle action with quick-make, quick-break mechanism. Trip indication shall be clearly shown by the breaker handle taking a position between on and off when the breaker is tripped. All multi-pole breakers shall be single-operated handle, internal common trip. Breakers having handle ties but not factory labeled "common trip" will be rejected. UL Class A ground fault circuit protection shall be provided on 120V AC branch circuits as specified on the plans or panelboard schedule. This protection shall be an integral part of the branch circuit breaker which also provides overload and short circuit protection for branch circuit wiring. Single pole 15 and 20 ampere circuit breakers shall be UL listed as "Switching Breakers" at 120V AC and carry the SWD marking. Tandem or "piggyback" breakers providing two circuits from one pole space are prohibited.
- C. Circuit Breakers - Distribution Panelboards:
 - 1. Molded case circuit breakers shall be rated 15 through 2500 amperes. Breakers covered under this specification may be applied in switchboards, panelboards, motor control centers, combination motor starter, busway plug-in units or individual enclosures.
 - 2. Molded case circuit breakers shall have overcenter, trip-free, toggle-type operating mechanisms with quick-make, quick-break action and positive handle indication. Two and three-pole breakers shall be common trip. Each circuit breaker shall have a permanent trip unit containing individual thermal and magnetic trip elements in each pole. Units shall be constructed to accommodate the supply connection at either end. Operating handles shall assume a center position when tripped. All breakers shall be calibrated for operation in an ambient temperature of 40 deg. C.
 - 3. Breakers shall have removable lugs. Lugs shall be UL listed for copper/aluminum conductors. Breakers shall be UL listed for installation of mechanical screw type lugs.

2.04 FUSES

- A. General: Except as otherwise indicated, provide fuses of types, sizes, ratings, and average time/current and peak let-through current characteristics indicated, which comply with manufacturer's standard design, materials, and construction in accordance with published product information, and with industry standards and configurations.
- B. Main Service Feeders and Branch Circuits: For switch rating over 600 amperes: Hi-Cap, Type KRP-C with interrupting rating of 200,000 amperes RMS. For switch rating 600 amperes or less: Low peak current limiting fuses, Type LPN(S)-R, with interrupting rating of 200,000 amperes RMS.
- C. Motors Above One (1) Horsepower: For fuse rating 600 amperes or less, dual element time delay, Type FRN(S)-R, with interrupting rating of 200,000 amperes RMS. Size fuses per Article 430 of the National Electric Code.
- D. Motors One (1) Horsepower or Less: Single phase 150 volts or less, Fustat fuses for motor running protection sizes. Single phase or three phase over 150 volts, Fustron fuses for motor running protection, with interrupting rating of 100,000 RMS. Size fuses per Article 430 of the National Electric Code.
- E. Fuses for all feeders, branch circuits, motors and other equipment shall be selected in types and ratings in accordance with NEC to provide a coordinated system of overcurrent protection, thus in case of a fault or harmful overload, only the fuses nearest the fault or overload will open.
- F. Provide one spare set of three (3) of each size and type of fuse used on project.

2.05 SURGE PROTECTIVE DEVICE (SPD)

- A. SPD shall meet UL 1449, 4th Edition, Type 2 requirement.
- B. SPD shall be integral to the panelboard.
- C. SPD shall have a minimum surge current capacity of 120,000A per phase, 60,000A per mode.
- D. Provide 60A circuit breaker to connect SPD to bus.

PART 3 - EXECUTION

3.01 INSTALLATION OF PANELBOARDS

- A. General: Install panelboards and enclosures where indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. Securely anchor panelboards to structure and make feeder and branch circuit connections as indicated in specifications and on the drawings.
- C. Each panelboard directory shall be typewritten to identify the load fed by each circuit. Spare breakers and circuits to be left blank with circuit breaker in off position.

END OF SECTION 26 24 16

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**SECTION 26 27 26
WIRING DEVICES**

PART 1 - GENERAL

1.01 RELATED WORK

- A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 26 0010 - Electrical General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

- A. Provide materials, equipment, labor and supervision necessary to install wiring devices as required by the drawings and this section.
- B. Types of wiring devices this section include the following:
 - 1. Straight blade receptacles
 - 2. GFI receptacles
 - 3. SPD receptacles
 - 4. USB charging receptacles
 - 5. Wall switches
 - 6. Wiring device accessories
 - 7. Cord reels
 - 8. Service poles

1.03 QUALITY ASSURANCE

- A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wiring devices.
- B. UL Compliance and Labeling: Provide electrical wiring devices which have been UL listed and labeled.
- C. NEMA Compliance: Comply with NEMA standards for general and specific purpose wiring devices.

1.04 SUBMITTALS

- A. Submit manufacturer's name and product data literature for each type of wiring device required.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
 - 1. Hubbell, Inc.
 - 2. Leviton Manufacturing Co., Inc.
 - 3. Pass & Seymour / Legrand

2.02 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Device Color:
 - 1. Device color shall be selected by the architect at the time of submittal review.
 - 2. Device color may not be consistent throughout the building. Select areas may require special colors. Refer to Architectural elevations and finishes.
 - 3. Device model numbers indicated below to not include a color suffix. Model numbers listed do not indicate brown device color.
 - 4. Where a device is shown connected to an emergency circuit, it shall have a "red" body.
- B. Modular Connectors: Devices that are manufactured for use with modular plug-in connectors (snap connect, plug tail, etc.) may be substituted. Plug in connectors shall meet the following conditions:
 - 1. Connectors shall comply with UL498 and shall be made with stranded building wire.

- C. Tamper Resistant:
 - 1. All 125V straight blade receptacles shall be tamper resistant.
- D. Weather Resistant:
 - 1. Devices located at exterior and wet locations shall be weather resistant. Provide weather resistant versions of the model specified.
 - 2. Refer to Part 3 - Execution section for required locations.
- E. Controlled Receptacles:
 - 1. Where receptacles that are noted to be automatically controlled through the lighting control system, they shall be permanently marked "CONTROLLED" with the controlled symbol as defined in NFPA 70.
 - 2. For duplex receptacles, one or both outlets shall be permanently marked as noted.
- F. Isolated Ground Receptacles:
 - 1. Devices marked 'IG' shall be Isolated Ground type.
 - a. Receptacle shall be orange in color and marked with a triangle symbol on the receptacle face.

2.03 STRAIGHT BLADE RECEPTACLES

- A. Heavy Duty Convenience Receptacles 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596. Tamper resistant.
 - 1. Hubbell HBL5361 (simplex), 5362 (duplex).
 - 2. Pass & Seymour 5361 (simplex), 5362 (duplex)
 - 3. Leviton 5361 (simplex), 5362 (duplex)
- B. Heavy Duty Hospital Grade Convenience Receptacles, 125 V, 20 A. Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596. Single-piece, nickel-plated, all-brass grounding system. Tamper resistant.
 - 1. Hubbell HBL8310 (simplex), 8300 (duplex).
 - 2. Pass & Seymour 8301 (simplex) 8300 (duplex)
 - 3. Leviton 8310 (simplex), 8300 (duplex).

2.04 GFCI RECEPTACLES

- A. Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596. Configuration 5-20R. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection. Self-testing, 4 to 6mA trip. Hubbell is basis of design. Other listed manufacturers are acceptable.
 - 1. Heavy duty tamper resistant: Hubbell GFTRST20
 - 2. Heavy duty tamper resistant and weather resistant: Hubbell GFTWRST20
 - 3. Heavy duty faceless. Hubbell GFBFST20
- B. Hospital grade, straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection. Self-testing, 4 to 6mA trip. Hubbell is basis of design. Other listed manufacturers are acceptable.
 - 1. Heavy duty standard. Hubbell GFRST83
 - 2. Heavy duty tamper resistant with alarm: GFTRST83
 - 3. Heavy duty tamper resistant and weather resistant: Hubbell GFTWRST83

2.05 USB CHARGING RECEPTACLES

- A. USB Charging Convenience Receptacles, 125 V, 20 A, tamper resistant. Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 1310, and FS W-C-596. Compatible with USB 1.1/2.0/3/0 devices, including Apple products. Class 2 power supply. Hubbell is basis of design. Other listed manufacturers are acceptable.
 - 1. 5VDC, 5A USB output. One USB Type A port and one USB Type C port. Hubbell USB20AC5

2.06 WALL SWITCHES

- A. Heavy duty industrial grade switch. Comply with NEMA WD 1, and FS W-S-896. Hubbell is basis of design. Other listed manufacturers are acceptable.
 - 1. Single pole toggle light switch 20 amp, 120 277 volt, Hubbell #1221 series.
 - 2. Double pole toggle light switch 20 amp, 120 277 volt, Hubbell #1222 series.
 - 3. Three way toggle light switch 20 amp, 120 277 volt Hubbell #1223 series.
 - 4. Four way toggle light switch 20 amp, 120 277 volt, Hubbell #1224 series.
 - 5. Double pole double throw center off light switch 20 amp, 277 volt, Hubbell #1386 series.
 - 6. Momentary contact switch 15 amp, 120 277 volt, Hubbell #1556 series.

2.07 WIRING DEVICE ACCESSORIES

- A. Cover Plates:
 - 1. Smooth High-Impact Thermo plastic (nylon, unbreakable), Hubbell NP Series or equal.
 - 2. Stainless steel, smooth metal, Type 302.
 - 3. Plates for surface outlets shall be of the raised cover type utilizing 4" square boxes.
 - 4. Outlets Installed Outdoors and in Wet Locations:
 - a. Weatherproof Flip Cover ("WP"): Weatherproof device covers shall consist of cast metal cover plate and cap over each opening. The cap shall be permanently attached to the cover plate by a spring hinged flap. The weatherproof integrity shall not be affected when heavy duty specification or hospital grade attachment plug caps are inserted. Cover plates on outlet boxes mounted flush in the wall shall be gasketed to the wall in a watertight manner.
 - 1) Horizontally mounted devices shall have cover plate aligned for same mounting, equal to Hubbell CWP series.
 - 2) Vertically mounted devices shall have cover plate aligned for same mounting, equal to Hubbell WP series.
 - b. Weatherproof Cord and Plug Cover ("WPD"): Extra duty, while-in-use, NEMA 3R cover. Heavy-duty die cast metal construction, UL 514D. Hubbell WP26 series or equal.

2.08 CORD REELS

- A. Complete cable reel assembly, UL 335 listed:
 - 1. Standard Duty: Hubbell inReach series, Gleeson ACA series, Legrand 1000 Series or equal.
 - a. 120V 3-wire cord, #12 AWG, 20A rated.
 - b. NEMA 1 steel or aluminum construction, powder-coated finish.
 - c. Adjustable roller cable guide. Wall or ceiling mount.
 - d. 20A rated slip ring, positive latch mechanism, adjustable ball stop.
 - e. Cord length and end as noted on plan.

2.09 SERVICE POLES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbell Wiring Device Kellems; HBL PP series service poles or comparable product by one of the following:
 - 1. MonoSystems.
 - 2. Wiremold.
- B. Description:
 - 1. Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.
 - 2. Poles: Nominal 2.5-inch square cross section, with height adequate to extend from floor to at least 6 inches above ceiling, and with separate channels for power wiring and communication cabling.
 - 3. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.
 - 4. Material and Finish: Painted steel.

5. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, four-pair, 6 communication cables.
6. Power Receptacles: Two duplex, 20-A, straight-blade receptacles complying with requirements in this Section.
7. Communication Outlets: Blank insert with bushed cable opening.

PART 3 - EXECUTION

3.01 INSTALLATION OF WIRING DEVICES

- A. Install wiring devices as indicated on the drawings and as called for below.
- B. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
- C. In masonry walls, switches and receptacle heights shall be adjusted as required so outlets are at nearest mortar joint to specified height.
- D. Where light switches are located adjacent to doors, they shall be installed on "knob" side of door, unless indicated otherwise.
- E. Switched duplex receptacles shall be wired so that only the top receptacle is switched; the remaining receptacle shall be unswitched.
- F. All GFI type receptacles shall be installed where GFI notation is shown on plans. No downstream protection of receptacles will be allowed from load side of other GFI type receptacles unless specifically noted on drawings.
- G. All GFI receptacles shall be accessible for testing. Where a GFI receptacle is located behind equipment, a faceless GFCI device shall be provided in an adjacent accessible location.
- H. All receptacles within 6' of the edge of a sink shall be GFI type, Contractor shall notify Engineer prior to installation if the drawings do not indicate these as GFI.
- I. Prior to roughing in outlet boxes, Contractor shall verify from general construction drawings, door swings, type of wall finishes and locations for counters and work benches.
- J. Receptacles shall be installed with ground terminal up. Horizontal receptacles shall be installed with the grounded (neutral) terminal up.
- K. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
- L. The grounding terminal of isolated ground receptacles shall be connected to an insulated equipment grounding conductor (green with yellow stripe) dedicated to that branch circuit. The receptacle box and device strap shall be connected to the branch circuit equipment ground conductor (green).
- M. All receptacles installed in damp and wet locations shall be weather resistant.
- N. All non-locking 15A and 20A receptacles in the following locations shall be tamper resistant regardless of mark on plans.
- O. All receptacles in healthcare related spaces shall be hospital grade. These rooms include, but are not limited to: Immunization Room, Procedure Room, Dental Room, Exam Room, Consult, Surgeon, and Lab.
- P. Cord reels shall be installed in accordance with the manufacturer's instructions.
 1. Cord reels shall be either directly secured to a structural component of the building or supported by channel strut. Provide safety cable.

3.02 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. Test Instruments: Use instruments that comply with UL 1436.
 2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

- B. Tests for Convenience Receptacles (10% of devices):
1. Line Voltage: Acceptable range is 105 to 132 V.
 2. Ground Impedance: Values of up to 2 ohms are acceptable.
 3. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 4. Using the test plug, verify that the device and its outlet box are securely mounted.
 5. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION 26 27 26

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**SECTION 26 28 16
ENCLOSED SWITCHES AND CIRCUIT BREAKERS**

PART 1 - GENERAL

1.01 RELATED WORK

- A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 26 00 10 - Electrical General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

- A. In general, disconnect switches and circuit breakers are indicated on the drawings, and it shall be the Electrical Contractor's responsibility to furnish and install all disconnect switches for equipment and motors furnished by them, and for equipment and motors furnished by others.
- B. Contractor shall furnish all equipment, materials, tools, labor and supervision necessary to install equipment as specified in this section and as called for on the drawings. All components necessary for a complete installation including, but not limited to fuses, fuse clips, channel strut support, lugs, etc. are to be included by the contractor.
- C. Types of switches and circuit breakers in this section include the following:
 - 1. Fusible and non-fusible disconnect switches.
 - 2. Elevator disconnect switches
 - 3. Motor rated toggle disconnect switches
 - 4. Plug fuse disconnect switches
 - 5. Enclosed circuit breakers
 - 6. Fuses

1.03 QUALITY ASSURANCE

- A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical motor and circuit disconnect switches.
- B. UL Compliance and Labeling: Provide motor and circuit disconnect switches which have been UL listed and labeled.
- C. NEMA Compliance: Comply with applicable requirements of NEMA Stds. Pub. No. KS 1.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's data including specifications, installation instructions and general recommendations, for each type of motor and circuit disconnect switch required.

PART 2 - PRODUCTS

2.01 FUSIBLE AND NON-FUSIBLE DISCONNECT SWITCHES

- A. Manufacturers:
 - 1. Schneider Electric/Square D (Basis of Design)
 - 2. ABB/GE Industrial Solutions
 - 3. Eaton
 - 4. Siemens
- B. Fusible Switch: NEMA KS 1, Heavy Duty, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C. Non-fusible Switch: NEMA KS 1, Heavy Duty, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- D. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors. Provide for all 4-wire feeds.
3. Auxiliary Contact Kit: Auxiliary set of contacts arranged to open before switch blades open. Provide for all switches on the load side of a VFD and elevator disconnects.
- E. Disconnects installed indoors shall have NEMA 1 enclosures, disconnects installed outdoors or in wet locations shall have raintight NEMA 3R enclosures. Disconnects specifically identified by '4X' shall have a stainless steel NEMA 4X enclosure.
- F. Disconnects used for service entrance equipment shall be labeled for such use.
- G. Disconnects that are part of a photovoltaic system shall be listed for such use.
- H. Disconnect switches for elevators served from the emergency power system shall be furnished with a 50kA surge protective device.
- I. All disconnects shall be of the fuse type, except where drawings indicate non fuse type (NF).

2.02 ELEVATOR DISCONNECT SWITCHES

- A. Manufacturers:
 1. Cooper/Bussmann
 2. Eaton
 3. Mersen
- B. Fusible Elevator Switch: Fusible power switch with internally powered shunt trip and fire safety interface to allow for single point tie in with fire alarm system.
 1. Externally operable fusible switch, current voltage rating as noted on the drawings.
 2. 120VAC control power transformer with primary and secondary fuses.
 3. "ON" Red Pilot Light
 4. Isolated Full Capacity Neutral Lug
 5. Control voltage monitoring relay to be monitored by the fire alarm system
 6. NEMA 1 Enclosure
 7. Main switch auxiliary contacts (1 NO/1 NC)
 8. Elevator disconnects served from the emergency power system shall be furnished with a 50kA surge protective device.

2.03 MOTOR RATED TOGGLE DISCONNECT SWITCHES

- A. Manufacturers:
 1. Schneider Electric/Square D (Basis of Design)
 2. ABB/GE Industrial Solutions
 3. Eaton
 4. Siemens
 5. Hubbell
 6. Pass & Seymour
- B. Description: Motor rated non-fused switch for ON-OFF control of single or three-phase motors and equipment where overload protection is not required. Square D class 2510, type K or equal.
 1. Compact construction.
 2. NEMA 1 enclosure or as noted with handle guard provision able to be locked in the open position.
 3. Two or three pole configurations, 600V rated.

2.04 PLUG FUSE DISCONNECT SWITCHES

- A. Manufacturers:
 1. Bussmann
- B. Description: Box cover switch and fuse holder for Fustat plug fuses.
 1. Bussmann type SSY, handy box mounted.
 2. 120V, single pole, 15A rated
 3. Plug fused sized for individual motor.

2.05 ENCLOSED CIRCUIT BREAKERS

- A. General: Except as otherwise indicated, provide circuit breakers and ancillary components, of types, sizes, ratings and electrical characteristics indicated, which comply with manufacturer's standard design, materials, components, and construction in accordance with published product information, and as required for a complete installation.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with fully connected rating to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A to 600A.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Electronic trip circuit breakers for breakers 800A frame and larger and for select emergency system circuit breakers. Circuit breakers to be provided with rms sensing and following field-adjustable settings:
 - a. Instantaneous trip pickup levels.
 - b. Instantaneous trip delay
 - c. Long- and short-time pickup levels.
 - d. Long- and short-time time adjustments.
 - e. Ground-fault pickup level, time delay, and I2t response where indicated. All circuit breakers on 4-wire systems indicated to have ground-fault sensing shall include neutral current transformers.
 - f. Provide an Arc-Flash Reduction Maintenance switch for all circuit breakers 1200A and larger.
 - 4. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
 - 5. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
 - 6. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
 - f. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
 - g. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
- C. Breakers shall have removable lugs. Lugs shall be UL listed for copper/aluminum conductors. Breakers shall be UL listed for installation of mechanical screw type lugs.
- D. Enclosed circuit breakers installed indoors shall have NEMA 1 enclosures, enclosed circuit breakers installed outdoors or in wet locations shall have raintight NEMA 3R enclosures.
- E. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors. Provide for all 4-wire feeds.
 - 3. Permanent provision for locking in the open position,

- F. Enclosed circuit breakers used for service entrance equipment shall be labeled for such use.

2.06 FUSES

- A. General: Except as otherwise indicated, provide fuses of types, sizes, ratings, and average time/current and peak let-through current characteristics indicated, which comply with manufacturer's standard design, materials, and construction in accordance with published product information, and with industry standards and configurations.
- B. Main Service Feeders and Branch Circuits: For switch rating over 600 amperes: Hi-Cap, Type KRP-C with interrupting rating of 200,000 amperes RMS. For switch rating 600 amperes or less: Low peak current limiting fuses, Type LPN(S)-R, with interrupting rating of 200,000 amperes RMS.
- C. Motors Above One-half (1/2) Horsepower: For fuse rating 600 amperes or less, dual element time delay, Type FRN(S)-R, with interrupting rating of 200,000 amperes RMS. Size fuses per Article 430 of the National Electric Code.
- D. Motors One-half (1/2) Horsepower or Less: Single phase 150 volts or less, Fustat fuses for motor running protection sizes. Single phase or three phase over 150 volts, Fustron fuses for motor running protection, with interrupting rating of 100,000 RMS. Size fuses per Article 430 of the National Electric Code.
- E. Fuses for all feeders, branch circuits, motors and other equipment shall be selected in types and ratings in accordance with NEC to provide a coordinated system of overcurrent protection, thus in case of a fault or harmful overload, only the fuses nearest the fault or overload will open.
- F. Provide one spare set of three (3) of each size and type of fuse used on project.

PART 3 - EXECUTION

3.01 INSTALLATION OF ENCLOSED SWITCHES AND CIRCUIT BREAKERS

- A. Install motor and circuit disconnect switches where indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products fulfill requirements.
- B. Install disconnect switches as follows:
 - 1. Heavy Duty Switches. All applications including motors, feeders, service entrance, and equipment.
 - 2. Elevator Disconnect Switches: Where specifically indicated for elevators.
 - 3. Motor Rated Toggle Disconnect Switch. May be used for motors and equipment 30 Amps or less where fuse protection is not required. Applications include heat pumps, pumps and fans, where not downstream of a VFD,
 - 4. Plug Fuse Disconnect Switch. May be used for 120 Volt motors, 1/2hp or less including furnaces, circulation pumps, and exhaust fans.
 - 5. Enclosed Circuit Breakers: Where specifically indicated.
- C. Install disconnect switches used with motor driven appliances, and motors and controllers within sight of controller position unless otherwise indicated.
- D. Install fuses in switches protecting equipment rated in accordance with nameplate maximum overcurrent protection noted on the equipment.
- E. Where a disconnect switch is installed downstream of a VFD, the disconnect switch shall be provided with make-before-break auxiliary contacts with control wires to the VFD to signal the VFD.
- F. Maintain all clearances required by the National Electrical Code.
- G. Where NEMA 3R equipment is specified for use in interior locations, installation shall maintain the weatherproof listing of the equipment.

3.02 INSTALLATION OF ELEVATOR DISCONNECT SWITCHES

- A. Install fuses as recommended by the elevator equipment installer.
- B. Coordinate the monitoring of control voltage with the fire alarm system installer in accordance with NFPA 72.
- C. Fire alarm system shall signal elevator disconnect to open, disconnecting power from to the elevator controller in accordance with ASME A17.1.
- D. Provide control wiring between switch position contacts and elevator controller. Coordinate with elevator installer.

END OF SECTION 26 28 16

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SECTION 26 43 13

SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.01 SUMMARY

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 00 10 - Electrical General Provisions are applicable to work required of this section.
- B. Section Includes: Surge Protective Devices (SPD) for Service Entrance and Branch Panel applications.

1.02 REFERENCES

- A. ANSI/IEEE C.62.41 and C62.45
- B. UL 1449 – 4th Edition
- C. UL 1283
- D. NEC – NFPA 70
- E. NEMA LS1
- F. NFPA
- G. OSHA
- H. IEEE Std. 1100

1.03 SUBMITTALS

- A. Shop Drawings: Provide Shop Drawings with wiring diagrams, installation information, testing and maintenance procedures, and operational information for the transient protection system. Shop Drawings shall be submitted to Design Professional for approval before starting actual fabrication.
- B. Submittals for Approval: Provide the following test data submittals:
 - 1. Manufacturer will provide UL-1449, Fourth Edition data card showing the Voltage Protection Rating (VPR) and “Engineering Considerations” for the specific catalog number submitted. “Typical” UL 1449 data is not acceptable. Test data shall be provided to demonstrate the short circuit current rating has been tested on a complete device.

PART 2 - EQUIPMENT

2.01 SERVICE ENTRANCE SPD

- A. Environmental
 - 1. General Requirements:
 - a. No audible noise shall be generated.
 - b. No appreciable magnetic fields shall be generated. System shall be capable of use directly in computer rooms in any location without danger to disc units, disk packs, or tapes.
 - c. Operating Conditions:
 - 1) 30 – 130 Degrees F
 - 2) 15 – 85 Percent Humidity Non-Condensing
 - d. Enclosure: The unit shall have a heavy duty NEMA 12 dust-tight, drip-tight enclosure unless specified otherwise.
 - e. Units mounted at service entrance equipment shall be Type 1 and 20kA I-nominal rated.
- B. General Requirements
 - 1. SPD shall be rated to match equipment voltage, 60 Hertz, 3-phase, 4-wire system and shall be connected in parallel with the main switchboard.

2. Quality: The manufacturer shall be ISO 9001 certified, demonstrating world-class quality systems for the design and manufacture of the SPD units.
 3. Unit shall be UL 1449, 4th Edition Listed. A SPD that is a UL "Recognized" component will not be accepted.
 4. Each surge suppression element (MOV) shall be individually fused so that a failure of one element and/or fuse shall not affect other surge suppression elements. SPD shall have a short-circuit rating of 200kAIC.
 5. Unit shall include solid-state, long-life externally mounted LED visual status indicators that indicate the on-line status and operational integrity of each phase of the unit.
 6. Unit shall have a Form C summary alarm output contact rated for at least 1 amp at 120VAC for remote annunciation of SPD status.
- C. Manufacturers and Specific Product Requirements
1. Acceptable Manufacturers: Subject to compliance with requirements of the Contract Documents, acceptable manufacturers are as follows:
 - a. ASCO Power Technologies
 - b. ABB / Current Technology
 - c. Raycap
 - d. Mersen
 - e. Transdector/LEA
 - f. Schneider Electric/Square D
 - g. Siemens
 - h. Eaton
 2. Unit shall provide maximum Voltage Protection Rating as indicated by UL 1449.
 3. The SPD will be modular in design. Separate and replaceable suppression modules will protect each mode (L-N, L-G, and N-G).
 4. The service entrance SPD will be capable of surviving 15,000 ANSI/IEEE, Category C3 (10kA) impulses without failure or degradation of original performance characteristics of more than 10%
 5. Unit shall have a maximum surge current rating of 125kA per mode (125,000 amperes L-N, 125,000 amperes L-G, and 125,000 amperes N-G), based on ANSI/IEEE C62.41 standard 8 by 20 microsecond current waveform.
 6. Unit shall be UL 1283 listed as an electromagnetic interference filter and provide 50 Ohm noise attenuation of at least 40 dB at 100 kHz, 30 dB at 1 MHz, 35 dB at 10 MHz, and 50 dB at 100 MHz.
 7. Unit shall include a built-in, push-to-test feature that tests the integrity of all modules, MOVs and fuses in the system
 8. Unit shall have an audible alarm with an alarm on/off switch to silence the alarm and a push-to-test switch to test the alarm function.
 9. A resettable counter shall be provided to totalize transient voltage surges in both the normal and common mode. The readout shall be at least a six-digit LCD located on the unit front cover and provided with a 10-year battery back-up to maintain counts in the event of power loss.
 10. Warranty: Manufacturer shall provide a product warranty for a period of not less than 10 years from date of installation. Warranty shall cover unlimited replacement of system protection modules during warranty period. The first 5 years of this warranty will include any field labor required to perform repair or replacement work.

2.02 BRANCH PANEL SPD

- A. Environments
1. General Requirements:
 - a. No audible noise shall be generated.
 - b. No appreciable magnetic fields shall be generated. System shall be capable of use directly in computer rooms in any location without danger to disc units, disk packs, or tapes.

- c. Operating Conditions:
 - 1) 30 – 130 Degrees F
 - 2) 15 – 85 Percent Humidity Non-Condensing
2. Enclosure: The unit shall have a heavy duty NEMA 12 dust-tight, drip-tight enclosure.
- B. General Requirements
 1. Branch Panel Equipment (where indicated on drawings): Rated to match equipment voltage, 60 Hertz, 3-phase, 4-wire distribution board or panelboard.
 2. Quality: The manufacturer shall be ISO 9001 certified, demonstrating world-class quality systems for the design and manufacture of the SPD units.
 3. Unit shall be UL 1449 4th Edition Listed. A SPD that is a UL “Recognized” component will not be accepted.
 4. Each surge suppression element (MOV) shall be individually fused so that a failure of one element and/or fuse shall not affect other surge suppression elements. SPD shall have a short-circuit rating of 200kAIC.
 5. Unit shall include solid-state, long-life externally mounted LED visual status indicators that indicate the on-line status and operational integrity of each phase of the unit.
 6. Unit shall have a Form C summary alarm output contact rated for at least 1 amp at 120VAC for remote annunciation of SPD status.
- C. Manufacturers and Product Requirements
 1. Acceptable Manufacturers: Subject to compliance with requirements of the Contract Documents, acceptable manufacturers are as follows:
 - a. ASCO Power Technologies
 - b. ABB - Current Technology
 - c. Raycap
 - d. Mersen
 - e. Transductor/LEA
 - f. Schneider Electric/Square D
 - g. Siemens
 - h. Eaton
 2. Unit shall provide maximum Voltage Protection Rating (VPR) as indicated by UL 1449.
 3. The branch panel SPD will be capable of surviving 10,000 ANSI/IEEE, Category C3 (10kA) impulses without failure or degradation of original performance characteristics of more than 10%
 4. Unit shall have a maximum surge current rating of 80kA per mode (80,000 amperes L-N, 80,000 amperes L-G, and 80,000 amperes N-G), based on ANSI/IEEE C62.41 standard 8 by 20 microsecond current waveform.
 5. Unit shall be UL 1283 listed as an electromagnetic interference filter and provide 50 Ohm noise attenuation of at least 40 dB at 100 kHz, 30 dB at 1 MHz, 35 dB at 10 MHz, and 50 dB at 100 MHz.
 6. Unit shall be provided with an integral, non-fused disconnect switch which causes no interruption to the protected load for testing and maintenance. Disconnect system shall not require removal or replacement for warranty or other repairs.
 7. Unit shall have an audible alarm with an alarm on/off switch to silence the alarm and a push-to-test switch to test the alarm function.
 8. A resettable counter shall be provided to totalize transient voltage surges in both the normal and common mode. The readout shall be at least a six-digit LCD located on the unit front cover and provided with a 10-year battery back-up to maintain counts in the event of power loss.
 9. Warranty: Manufacturer shall provide a product warranty for a period of not less than 5 years from date of installation.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. General Requirements:
 - 1. Contractor shall install suppression system immediately next to or on top of service equipment where so approved by the Design Professional.
 - 2. Conductors between suppressor and point of attachment to service equipment shall be sized in accordance with manufacturer's Shop Drawings and conductor lengths shall be as short as possible, preferably not exceeding 24".
 - 3. Use SPD low-impedance cable listed for the application to enhance clamping voltage where unit is not mounted on or within equipment that it's protecting.
- B. Grounding: Suppressor ground shall be bonded to the equipment grounding busbar.

END OF SECTION 26 43 13

**SECTION 26 50 00
LIGHTING**

PART 1 - GENERAL

1.01 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 00 10 - Electrical General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

- A. Provide lighting fixtures, accessories, labor and supervision necessary to install complete lighting system as required by the drawings and this section.
- B. Types of lighting fixtures in this section include the following:
 - 1. Fluorescent
 - 2. Fluorescent Battery Packs
 - 3. Incandescent
 - 4. High Intensity Discharge
 - 5. Solid State (LED)
 - 6. Exit Signs
 - 7. Emergency
 - 8. Lamps
 - 9. Exterior Luminaires

1.03 QUALITY ASSURANCE

- A. NEC Compliance: Comply with NEC as applicable to installation and construction in building lighting fixtures.
- B. NEMA Compliance: Comply with applicable requirements of NEMA standard publications pertaining to lighting equipment.
- C. Listings: Provide lighting fixtures which have been listed and labeled. Listing or labeling shall be by UL, ETL Intertek or other nationally recognized agency.
- D. CBM Labels: Provide fluorescent lamp ballasts which comply with Certified Ballast Manufacturers Association standards and carry the CBM label.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's data on interior and exterior lighting fixtures.
- B. Shop Drawings: Submit fixture shop drawings in pdf form with separate sheet(s) for each fixture type arranged in alphabetical order. Include proposed options and accessories clearly indicated on each sheet.
 - 1. Submittal shall indicate the specific lumen output and power consumption for each fixture type.
 - 2. For fixtures requiring field assembly provide factory generated shop drawings indicating feed points, joint locations, and assembly instructions.
 - 3. Include driver product data for each fixture type.
 - 4. The pdf shall be book-marked by the fixture type. Submittal that are not bookmarked will be returned without review.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturers shall be as listed in the light fixture schedule on the drawings.

- B. Basis of Design Product: The design for each luminaire is based on the product named and described in the light fixture schedule on the drawings. Provide either the named product or a comparable product by one of the equivalent manufacturers listed. Equivalent manufacturers shall match the basis of design product in both form and function. The Architect and Engineer have the final acceptance of equivalent products. Where equivalent products are not determined to match the basis of design, the basis of design product shall be provided at no additional cost to the Owner. Upon request, equivalent manufacturers shall submit lighting calculations and ies files to prove performance of product and samples for table top viewing.

2.02 FLUORESCENT FIXTURES

- A. All plastic lenses for lay-in 2x4 prismatic fluorescent fixtures shall be not less than 1/8" nominal thickness. Lens shall have straight flat prism surfaces with maximum .080 penetration.
- B. Temperature around ballast and in fixture housing shall not exceed 90 deg.C with ambient room temperature of 27 deg.C.
- C. Electronic Ballast: Programmed rapid start; NEMA Premium, UL listed; sound rated A or better; Class P; capable of operating standard or energy-saving lamps at 20 KHz or greater, with voltage rating matching branch circuit voltage; with characteristics as follows:
1. Manufacturers:
 - a. Philips Advance
 - b. Universal Lighting Technologies
 - c. General Electric
 - d. Osram-Sylvania
 2. FCC certified, part 15, subpart J, for electromagnetic interference.
 3. Transient protected to withstand line transients as defined in IEEE Publication 587, categories A and B.
 4. Total Harmonic Distortion: 10% or less.
 5. Minimum Power Factor: .94
 6. Minimum Ballast Factor: 0.88 for T8 lamps; 0.95 for T5 lamps unless otherwise noted in the light fixture schedule
 7. Provide independent laboratory test report upon special request.
 8. Warranty: Provide written 5-year warranty against mechanical or electrical defects.
 9. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C 82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail. Series wired lamp circuits are not allowed.
- D. Electronic Dimming Ballast, 0-10V: NEMA Premium; UL listed; sound rated A or better; Class P; capable of operating standard lamps at 20 KHz or greater, with voltage rating matching branch circuit voltage; with characteristics as follows:
1. Manufacturers:
 - a. Philips Advance
 - b. Universal Lighting Technologies
 - c. General Electric
 - d. Osram-Sylvania
 2. Capable of dimming fluorescent lamps from 100% to 10% light output unless otherwise noted in the light fixture schedule.
 3. FCC certified, part 18, EMI/RFI.
 4. Transient protected to withstand line transients as defined in IEEE Publication 587.
 5. Total Harmonic Distortion: 10% or less.
 6. Minimum Power Factor: .90 full on, .80 low dim.
 7. Minimum Ballast Factor: 0.90; not adversely affecting lamp life.
 8. Dimming Type: 0-10V control with current source ballast, current sinking ballasts are not allowed.
 9. Provide independent laboratory test report upon special request.
 10. Warranty: Provide written 5-year warranty against mechanical or electrical defects.

11. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.
- E. Ballast for fluorescent fixtures controlled by dimmers shall be dimming type ballast as recommended by the dimmer manufacturer.
- F. Recessed fixtures in plaster ceilings shall be furnished with plaster frames.
- G. Prior to releasing order for fluorescent fixtures, Contractor shall verify the types of ceilings and suspension systems that have been approved for the project and shall order fixtures with flanges as required to fit in the approved ceilings.
- H. Light fixtures shall comply with NEC for disconnecting means requirements. Provide disconnect internal to fixture.

2.03 FLUORESCENT BATTERY PACK UNIT

- A. General: Unit shall have a high temperature nickel-cadmium type battery, 120/277 VAC universal input, UL listed, 3-year warranty, test switch. Acceptable manufacturers, subject to compliance with requirements, as follows:
 1. Phillips-Bodine
 2. Dual-Lite
 3. IOTA Engineering
- B. Tube Fixtures: Unit shall illuminate two lamps to 300-350 lumens each for 90 minutes. They shall be compatible with electronic, energy saving and dimming ballasts, and standard energy saving lamps.

2.04 INCANDESCENT FIXTURES

- A. Recessed fixtures shall be furnished with gaskets, so designed and installed that they will completely eliminate light leakage between flanges and ceilings.
- B. All recessed incandescent fixtures shall be equipped with a thermal resetting device in compliance with UL Standard 1571.

2.05 HIGH INTENSITY DISCHARGE FIXTURES

- A. High Intensity Discharge Lamp Ballasts: Provide high power factor HID lamp ballasts, of ratings, types and makes which properly match lamps to power line by providing appropriate voltages and impedances for which lamps are designed. Manufacturers to be Advance, Universal or Magnetek.

2.06 SOLID STATE LIGHTING / LIGHT EMITTING DIODE (LED) LUMINAIRES (Greater than 20W)

- A. General:
 1. Luminaire manufacturer shall have a minimum of five (5) years' experience in the manufacture and design of LED products and systems.
 2. All LED sources used in the LED luminaire shall be of proven quality from established and reputable LED manufacturers. Acceptable LED lamp manufacturers unless otherwise noted are:
 - a. Cree, Inc.
 - b. Philips Lighting
 - c. Nichia Corporation
 - d. Norlux
 - e. Opto Technology, Inc.
 - f. Osram Optronic Semiconductors
 - g. Samsung
- B. LED Warranty
 1. Luminaire manufacturer to provide a five (5) year written warranty.
- C. Replacement and Spares:
 1. The following requirements apply to all LED fixtures except: Fixture Type __, __, __.

2. Manufacturer shall provide written guarantee of the following:
 - a. Manufacturer shall be able to provide compatible replacement parts that are designed to fit into original luminaire for ten (10) years.
 - b. Replacement LED array/module shall be within 3 MacAdam color ellipse, within 10% of lumen output, 7% of correlated color temperature (CCT) and equivalent distribution of original array/module.
 - c. Replacement LED array/module shall utilize equal to or less than amount of wattage of original array/module.
 3. LED driver and array/module shall be replaceable in field.
- D. Products and Components – Performance:
1. All LED components shall be mercury-free and lead-free.
 2. LEDs shall comply with ANSI/NEMA/ANSLG C78.377-2008 – Specifications for the Chromaticity of Solid State Lighting Products. Color shall remain stable throughout the life of the light source.
 3. LEDs shall comply with IESNA LM-80 – Standards for Lumen Maintenance of LED Lighting Products.
 4. LEDs shall have a minimum rated source life of 50,000 hours under normal operating conditions or as noted on the lighting fixture schedule. LED “rated source life” is defined as the time when a minimum of 70% of initial lumen output remains, as defined by IESNA LM-70.
 5. Luminaire assembly shall include a method of dissipating heat so as to not degrade life of source, electronic equipment, or lenses. LED luminaire housing shall be designed to transfer heat from the LED board to the outside environment. Luminaire housing shall have no negative impact on life of components. Upon request, manufacturer shall provide junction temperature limitations and test reports of installed LED in fixture.
 6. Method of dissipating heat shall be passive, active cooling systems are not allowed.
 7. High power LED luminaires shall be thermally protected using one or more of the following thermal management techniques: metal core board, gap pad, and/or internal monitoring firmware.
 8. LEDs shall be adequately protected from moisture or dust in interior applications.
 9. For wet and damp use, LED-based luminaires itself shall be sealed, rated, and tested for appropriate environmental conditions, not accomplished by using an additional housing or enclosure. Such protection shall have no negative impact on rated life of source or components, or if so, such reductions shall be explicitly brought to the attention of the designer.
 10. All hardwired connections to LED luminaires shall be reverse polarity protected and provide high voltage protection in the event connections are reversed or shorted during the installation process.
 11. Manufacturer shall provide Luminaire Efficacy (lm/W), total luminous flux (lumens), luminous intensity (candelas) chromaticity coordinates, CCT and CRI. Optical performance, polar diagrams, and relevant luminance and illuminance photometric data. Provide data in IES file format in accordance with IES LM-79-2008, based on test results from an independent Nationally Recognized Testing Laboratory. Provide information upon special request.
- E. LED drivers shall meet the following requirements:
1. Drivers shall have a minimum efficiency of 85%.
 2. Minimum/Maximum Ambient Temperature: -20°C/55°C interior locations, -40°C/55°C exterior locations,
 3. Input Voltage: 120 to 277 (±10%) V or as scheduled.
 4. Power Supplies: Class I or II output.
 5. Dimming Type: 0-10V control with current source driver, current sinking drivers are not allowed.

6. Surge Protection for exterior fixtures: The system must survive 250 repetitive strikes of "C Low" (C Low: 6kV/1.2 x 50 μ s, 10kA/8 x 20 μ s) waveforms at 1-minute intervals with less than 10% degradation in clamping voltage. "C Low" waveforms are as defined in IEEE/ASNI C62.41.2-2002, Scenario 1 Location Category C.
7. Power Factor (PF): ≥ 0.90 .
8. Total Harmonic Distortion (THD): $\leq 20\%$.
9. Comply with FCC Title 47 CFR Part 18 Non-consumer RFI/EMI Standards.
10. Drivers shall be reduction of hazardous substances (ROHS)-compliant.
11. Mean Time Between Failure (MTBF): 100,000 hours based on 90% survival.

2.07 EXIT SIGNS

- A. Housing to be per light fixture schedule (thermoplastic, edge lit or cast aluminum) for wall, end or ceiling mounting. Illumination to be by long life, low watt LED lamps. Battery, where specified, to be maintenance free, sealed nickel-cadmium type and shall operate sign for 90 minutes after loss of power.

2.08 EMERGENCY FIXTURES

- A. Housing and lamping per light fixture schedule. Self-contained complying with UL 924. Battery to be premium grade, lead-acid or nickel cadmium, maintenance free battery and shall operate sign for 90 minutes after loss of power.

2.09 LAMPS

- A. Lamps shall be General Electric, Philips, Osram-Sylvania.
- B. Furnish lamps for all fixtures as per schedule on drawings.
- C. All incandescent lamps shall be 130 volt rated and fluorescent lamps shall be energy saving type where applicable.

2.10 EXTERIOR LUMINAIRES

- A. General:
 1. Poles shall be as shown on the drawings, and as specified. The pole and arm assembly shall be designed for wind loading of 100 mph with an additional 30% gust factor, supporting luminaire(s) and accessories such as shields, banner arms, and banners.
 2. Poles shall have handhole having a minimum clear opening of 2.5 x 5 in. Handhole covers shall be secured by stainless steel captive screws.
 3. Provide a steel-grounding stud opposite handhole openings, designed to prevent electrolysis when used with copper wire.
 4. Provide a base cover that matches the pole in material and color to conceal the mounting hardware pole-base welds and anchor bolts. Plastic base covers are not allowed.
 5. Hardware and Accessories: All necessary hardware and specified accessories shall be the product of the pole manufacturer.
 6. Provide manufacturer's standard finish and color, as scheduled on the drawings. Provide custom finishes only where specifically indicated on the drawings.
- B. Pole Types:
 1. Aluminum: Provide aluminum poles manufactured of corrosion-resistant AA AAH35.1 aluminum alloys conforming to AASHTO LTS-4. Poles shall be seamless extruded or spun seamless type. Poles 12' or greater in height shall be provided with an internal, factory installed, vibration damper.
 2. Steel: Provide steel poles having minimum 11-gauge steel with minimum yield/strength of 48,000 psi. Poles 12' or greater in height shall be provided with an internal, factory installed, vibration damper.
 3. Prestressed Concrete: Provide prestressed concrete, raceway-type, lighting poles of the size and type indicated. Provide luminaire brackets as required for complete assemblies.
- C. Foundations for Poles:
 1. Foundations shall be cast-in-place concrete, having 3000 psi minimum 28-day compressive strength.

2. Place concrete in spirally-wrapped treated paper forms for round foundations, and construct forms for square foundations.
3. Rub-finish and round all above-grade concrete edges to approximately 0.25 in radius.
4. Anchor bolt assemblies and reinforcing of concrete foundations shall be as shown on the drawings. Anchor bolts shall be in a welded cage or properly positioned by the tie wire to stirrups.
5. Prior to concrete pour, install ground electrode.

PART 3 - EXECUTION

3.01 INSTALLATION OF INTERIOR LIGHTING FIXTURES

- A. Install interior lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of the National Electric Code (NEC), NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.
- B. All low-voltage luminaires using remote drivers or power supplies shall be installed as follows:
 1. Installation shall be in compliance with the manufacturer's instructions including distance limitations.
 2. Remote drivers and power supplies shall be located in accessible locations and clearly noted on as-built plans. Where plywood is used for power supply mounting, plywood shall be UL Listed fire resistant.
 3. Unless specifically noted "Class 2", all low-voltage wiring between remote drivers or power supplies and luminaires shall be considered Class 1 and installed in accordance with NEC Article 725. Wiring shall be 600V rated and installed in conduit.
 4. All remote drivers and power supplies not specifically labeled "Class 2" on the power supply housing shall be installed in a ventilated metal enclosure. Where the power supply includes cooling fan or convection cooling, ventilation openings in enclosure shall be provided to not impede power supply cooling.
- C. Coordinate with other electrical work as appropriate to properly interface installation of interior lighting fixtures with other work.
- D. Coordinate fixture location with reflected ceiling plan.
- E. Recessed fixtures in removable ceilings shall be connected to the branch circuit with flexible conduit and branch circuit wire from an accessible junction box. Where fluorescent fixture housings are connected together, use 90 deg.C wire for branch circuit feed through fixture channels.
- F. All fixtures shall be grounded. All lamp sockets shall be wired so that the outer shell is connected to the neutral grounded conductor.
- G. Fixtures recessed in furred ceiling shall be installed so that they can be removed from below the ceiling.
- H. For all dimmed light fixtures, "burn in" or "season" lamps prior to dimming as recommended by the lamp manufacturer.
- I. Luminaires located in suspended ceilings shall be connected with a maximum 6 foot length of flexible metal conduit and building wire.
- J. Housing, trim, and lens frame shall be true, straight and parallel to each adjacent fixtures and features.
- K. Contractor shall include all materials and labor necessary for the final aiming and adjusting of adjustable light fixtures. Adjustment of light fixtures may be required to occur after sunset at a time designated by the Engineer.
- L. Round fixtures or fixtures smaller than the ceiling grid shall have at least two (2) 3/4 inch (19 mm) metal channels spanning, and secured to, the ceiling tees for centering and aligning the fixture.

- M. Troffer, recessed and semi-recessed fixtures shall be installed at a minimum per the manufacturer's instructions and the requirements below. Fixtures shall not be supported directly on the ceiling material. Support fixtures with metal bar hangers or strut channels attached to the ceiling tees. Coordinate with Ceiling Contractor to ensure ceiling tees can support the weight of the light fixtures.
- N. Suspended Linear or Pendant mounted fixtures shall be independently supported from the building structure by wires, straps or rods.
- O. Fixture whips shall be in accordance with section 26 05 33 Raceway and Boxes for Electrical Systems.

3.02 INSTALLATION OF EXTERIOR LIGHTING FIXTURES

- A. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole. Install poles plumb and level.
- B. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer.
- C. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
- D. Embedded Poles with Tamped Earth Backfill: Set poles to depth below finished grade indicated on drawings, but not less than one-sixth of pole height. Dig holes large enough to permit use of tampers in the full depth of hole. Backfill in 6 inch layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.
- E. Coordinate locations and elevations of base mounted site fixtures with site plans, do not scale electrical drawings for placement of light poles.

END OF SECTION 26 50 00

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**SECTION 27 00 10
COMMUNICATIONS GENERAL PROVISIONS**

PART 1 - GENERAL

1.01 GENERAL

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

1.02 DESCRIPTION OF WORK

- A. This section applies to all work under the telecommunications contract. This shall include, but not necessarily be limited to, the following:
 - 1. Pre-Register Project with structured cabling plant manufacturer if applicable.
 - 2. Furnish and install a complete voice and data-wiring infrastructure.
 - 3. Furnish, install, and terminate all UTP cable and fiber as applicable and per drawings.
 - 4. Furnish and install all wall plates, jacks, patch panels, and patch cords as required and as indicated.
 - 5. Furnish and install any cabinets, racks and ladder rack as required and as indicated.
 - 6. Furnish any other material required to form a complete system.
 - 7. Perform permanent link testing (100% of links) and certification of all components.
 - 8. Furnish test results of all cabling to the owner on disk and paper format, listed by each closet, then by workstation ID.
 - 9. Provide Owner As-builts in the form of one electronic copy and two hard copies of a labeled map of the building(s) showing the structured cabling plant.
 - 10. Adhere and comply with all requirements of the Contractor Agreement for the structured cabling plant manufacturer to be used.
 - 11. Provide Owner training and testing documentation.
- B. The work shall include all materials, equipment and labor required for complete and properly functioning telecommunications systems.
- C. All elements of the construction shall be performed by workmen skilled in the particular craft involved, and regularly employed in that particular craft.
- D. All work shall be performed in a neat, professional manner in keeping with the highest standards of the craft.

1.03 CODES AND STANDARDS

- A. All work shall be done in accordance with the applicable portion of the following codes and standards:
 - 1. National Electrical Code
 - 2. Local Electrical Code
 - 3. National Fire Protection Association
 - 4. National Electrical Manufacturers Association
 - 5. Standards of Institute of Electrical and Electronic Engineers
 - 6. Applicable Building Codes
 - 7. Occupational Safety and Health Act
 - 8. Iowa Administrative Codes
 - 9. ANSI TIA-526-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
 - 10. ANSI TIA-526-14-C Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
 - 11. ANSI TIA-568-D.1 Commercial Building Telecommunications Cabling Standard Part 1: General Requirements
 - 12. ANSI TIA-568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standards
 - 13. ANSI TIA-568-C.3 Optical Fiber Cabling Components Standard
 - 14. ANSI TIA-568-C.4 Broadband Coaxial Cabling and Components Standard

15. ANSI TIA-569-D Telecommunications Pathways and Spaces
16. ANSI TIA-570-C Residential Telecommunications Infrastructure Standard
17. ANSI TIA-598-D Optical Fiber Cable Color Coding
18. ANSI TIA-606-B Administration Standard for Commercial Telecommunications Infrastructure
19. ANSI TIA-607-B Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
20. ANSI TIA-758-B Customer-owned Outside Plant Telecommunications Infrastructure Standard
21. National Fire Protection Agency (NFPA - 70), National Electrical Code (NEC)

- B. All Contractors shall familiarize themselves with all codes and standards applicable to their work. No extra compensation will be allowed for corrections or changes in the work required due to failure to comply with the applicable codes and standards. Where two or more codes or standards are in conflict, that requiring the highest order of professionalism shall take precedence, but such questions shall be referred to Design Professional for final decision.

1.04 REQUIREMENTS & FEES OF REGULATORY AGENCIES

- A. Contractor shall comply with the rules and regulations of the local serving utility companies and shall check with each utility company providing service to this project and determine or verify their requirements regarding incoming services.
- B. Secure and pay for all permits, licenses, fees and inspections.

1.05 DRAWINGS

- A. Drawings for the work are in part diagrammatic, and are intended to convey the scope of the work and to indicate in general the location of equipment.
- B. Contractor shall layout their own work and shall be responsible for determining the exact quantities and locations for equipment.
- C. Contractor shall take own field measurements for verifying locations and dimensions; scaling of the drawings will not be sufficient for laying out the work.
- D. Because of the scale of the drawings, certain basic items for a complete installation are not shown, but where such items are required by code (or referenced standards) where they are required for proper installation and operation of the work, such items shall be furnished and installed.

1.06 ACTIVE SERVICES

- A. Contractor shall be responsible for verifying exact locations of all existing services prior to beginning work in that area.
- B. When active services are encountered which require relocation, Contractor shall make request to authorities with jurisdiction for determination of procedures.
- C. Where existing services are to be abandoned, they shall be terminated in conformance with requirements of the authorities having jurisdiction.

1.07 SITE INSPECTION

- A. Contractor shall inspect the site prior to submitting bid for work to become familiar with the conditions of the site which will affect the work and shall verify points of connection with utilities and/or existing system wiring.
- B. Extra payment will not be allowed for changes in the work required because of Contractor's failure to make this inspection.

1.08 COORDINATION AND COOPERATION

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

- B. Contractor shall fully examine the drawings and specifications for other trades and shall coordinate the installation of their work with the work of the other contractors. Contractor shall consult and cooperate with the other contractors for determining space requirements and for determining that adequate clearance is allowed with respect to their equipment, other equipment and the building. The Design Professional reserves the right to determine space priority of the contractors in the event of interference between piping, conduit, ducts and equipment of the various contractors.
- C. Drawings and specifications are intended to be complimentary. Any work shown in either of them, whether in the other or not, shall be executed according to the true intent and meaning thereof, the same as if set forth in all. Conflicts between the drawings and the specifications, or between the requirements set forth for the various contractors, shall be called to the attention of the Design Professional. If clarification is not asked for prior to the taking of bids, it will be assumed that none is required and that Contractor is in agreement with the drawings and specifications as issued. If clarification is required after the contract is awarded, such clarification will be made by Design Professional and their decision will be final.
- D. Special care shall be taken for protection for all equipment. All equipment and material shall be completely protected from weather elements, painting, plaster, etc., until the project is substantially completed. Damage from rust, paint, scratches, etc., shall be repaired as required to restore equipment to original condition.
- E. Protection of all equipment during the painting of the building shall be the responsibility of the Painting Contractor, but this shall not relieve Contractor of the responsibility for checking to assure that adequate protection is being provided.
- F. Where the final installation or connection of equipment in the building requires Contractor to work in areas previously finished by Owner, the Contractor shall be responsible that such areas are protected and are not marred, soiled or otherwise damaged during the course of such work. Contractor shall be responsible for patching and refinishing of such areas which may be damaged in this respect.
- G. Where two or more specified items/systems in the specifications and/or the drawings are in conflict, that requiring the highest order of professionalism and the most financially expensive products shall take precedence. Such questions shall be referred to the Design Professional for final decision.

1.09 MATERIALS AND EQUIPMENT

- A. All materials and equipment shall be the standard product of a reputable manufacturer regularly engaged in the manufacture of the specified item unless authorized in writing by Design Professional. Where more than one unit is required of the same items, they shall be furnished by the same manufacturer except where specified otherwise.
- B. All material and equipment shall be installed in strict accordance with the manufacturer's recommendations.
- C. The equipment specifications cannot deal individually with any minute items such as parts, controls, devices, etc., which may be required to produce the equipment performance and function as specified, or as required to meet the equipment guarantees. Such items when required shall be furnished as part of the equipment, whether or not specifically called for.

1.10 SUBMITTALS

- A. Contractor shall furnish, to the Design Professional, complete sets of submittals. Contractor shall review and sign submittals before submitting. Contractor shall provide submittals via electronic process (.PDF format) unless otherwise instructed. Refer to Division 01 specifications for additional requirements
- B. Submittals required by the various sections of the Project Manual include, but are not necessarily limited to those identified in the submittal schedule below.

- C. After award of contract, the contractor shall provide a completed submittal schedule including dates that the submittals will be to the Design Professional for review. Submit required information on all items in the project for the following systems (see table). Submittals shall be sorted and separately identified per specification section listed below.

SPEC SECTION	EQUIPMENT	DETAIL DWGS	PROD DATA	SAMPLES	INSTALL METHODS	O & M MANUAL	CERTIFICATE OF SYSTEM DEMONSTRATION	OTHER (SEE NOTES)
27 00 10	Contractor Certifications					X		Note 1,8
27 00 10	Manufacturer Certification					X		Note 2,8
27 00 10	UTP No-Paint Notification					X		Note 7,8
27 0526	Grounding Equipment		X			X		Note 8
27 0526	Grounding Cabling		X			X		Note 8
27 0526	Grounding Hardware		X			X		Note 8
27 11 00	UTP Cabling/Equipment		X			X	X	Note 6,8
27 1323	Fiber Cabling/Equipment		X			X	X	Note 6,8
27 11 00	IDC/Lightning Blocks		X			X	X	Note 6,8
27 1116	Data Racks/Cabinets		X			X		Note 8
27 11 16	Cable Management		X			X	X	Note 6,8
27 11 00	As-Builts at Closeout							Note 3,8
27 12 00	Tester, UTP/Fiber		X			X		Note 4,8
27 12 00	Test Report at Closeout					X		Note 5,8
27 40 00	AV System	X	X			X		Note 8
27 4500	Sound Masking	X	X			X		Note 8
27 5000	Paging	X	X			X		Note 8
27 5129	Emergency Communication	X	X			X		Note 8

Notes:

1. Division 27 Contractor shall submit copies of the Contractor Certifications under section 27 00 10 (BICSI or IBEW/NECA Certifications) showing compliance with the specification. See Approved Contractors paragraph for details.
2. Division 27 Contractor shall submit Manufacturer Certification under section 27 00 10. See Approved Contractors paragraph in this section for details, and further requirements listed in Cabling and Equipment specification section.
3. Division 27 Contractor shall submit As-Builts as specified in Cabling and Equipment section.
4. Division 27 Contractor shall submit product information on UTP Tester and Fiber Tester. See testers specified in Testing and Documentation section.
5. Division 27 Contractor shall submit Test Report as specified in Testing and Documentation section.
6. Grounding and Bonding or Cabling and Equipment section submittals will not be opened or reviewed by the Design Professional until the Division 27 00 10 Contractor Certifications (see Note 1) and Division 27 Manufacturer Certifications (see Note 2) have been received and found to be acceptable by the Design Professional.
7. Division 27 Contractor shall submit the "Do Not Paint The UTP" written notification (addressed to the General Contractor) for review by the Design Professional. This written notification is specified in the Telecommunications Cabling and Equipment section. The submittal process may be used as the vehicle to inform the General Contractor of the "Do Not Paint The UTP" requirement (and the mandatory corrections required if this were to happen, outlined in the Telecommunications Cabling and Equipment section) if the General Contractor acknowledges receipt of the written notification.
8. The design professional will not review any submittals before receiving the Division 27 0010 Contractor and Manufacturer certification submittals.

1.11 OPERATION AND MAINTENANCE MANUALS

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

1.12 TESTS AND DEMONSTRATIONS

- A. All systems shall be tested by Contractor and placed in proper working order prior to demonstrating systems to Owner.

1.13 TRAINING AND DEMONSTRATIONS

- A. Prior to acceptance of the telecommunications installation, the Contractor shall provide to Owner, or their designated representatives, all comprehensive training on essential features and functions of all systems installed, and shall instruct Owner in the proper operation and maintenance of such systems.
 - 1. Provide adequate notice to Owner as to when instruction will be conducted so appropriate personnel can be present.
 - 2. Prepare the instruction format for a minimum of four Owner Representatives.
- B. Equipment training:
 - 1. Manufacturer's representatives shall provide instruction on each major piece of equipment. Contractor shall provide instruction on all other equipment.
 - 2. Training sessions shall use the printed installation, operation and maintenance instruction materials included in the O&M manuals and emphasize preventative maintenance and safe operating procedures.
 - 3. Training shall be performed by qualified factory trained technicians.
 - 4. Contractor shall attend all sessions performed by the manufacturer's representative and shall add to each session any special information relating to the details of installation of the equipment as it might impact the operation and maintenance.
 - 5. Equipment training shall occur as soon as possible after start up of the equipment and shall include hands-on operation. Training shall be provided for equipment listed in the table below.
- C. System training:
 - 1. Training sessions shall include hands-on demonstrations of system wide start-up, operation in all possible modes, shut-down and emergency procedures.

D. The following are minimum requirements for Owner instruction:

Section	Description	Hrs. on Site	Presented By	Others Present	Remarks
27 40 00	Audiovisual System	4	Contractor		
27 45 00	Sound Masking System	1	Contractor		
27 50 00	Paging System	2	Contractor		
27 51 29	Emergency Communication	2	Contractor		

- E. Each Contractor shall submit a certificate (in the project closeout submittals), signed by Owner stating the date, time and persons instructed and that the instruction has been completed to Owner's satisfaction. An example of a certificate form is as follows:

CERTIFICATE OF SYSTEM DEMONSTRATION

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

- A. Project:
- B. System(s):
- C. Contractor's representatives giving instruction and demonstration:

Contractor: _____

NAMES	DATE	HOURS

- D. Owner's representatives receiving instruction:

Owner: _____

NAMES	DATE	HOURS

- E. Acknowledgement of demonstration:

Contractor's Representative:

_____ signature

_____ date

Owner's Representative:

_____ signature

_____ date

1.14 PERMITS, FEES, ETC.

- A. Secure all required permits and pay for all inspections required in connection with the telecommunication systems work. Contractor shall post all bonds and obtain all licenses required by the State, City, County, and Federal Agencies.

1.15 SUBSTITUTIONS

- A. To obtain approval to use unspecified equipment, Bidding Contractors (not equipment supplier, manufacturers, etc.) shall submit written requests to Design Professional at least 10 days prior to bid due date. Requests shall clearly describe the equipment for which approval is being requested. Include all data necessary to demonstrate that equipment's capacities, features and performance are equivalent to include a cost comparison between specified equipment and equipment for which approval is being requested. If the equipment is acceptable, Design Professional will approve it in an addendum. The Design Professional will, under no circumstances, be required to prove that an item proposed for substitution is or is not of equal quality to the specified item.
- B. Where substitutions are approved, Contractor assumes all responsibility for physical dimensions and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of the substitution.

1.16 APPROVED CONTRACTORS

- A. **MANUFACTURER CERTIFICATION:** Contractor shall be a manufacturer certified installer for the structured cabling plant. A copy of the current annual manufacturer certification shall be provided with 27 00 10 submittals. Contractor is responsible for professionalism and installation practices in accordance with the manufacturer requirements and shall be authorized to provide an extended Manufacturer's Product Warranty with their installation. The specific warranty program that is acceptable for each solution is listed with the connectivity solution in specification section 27 11 00 TELECOMMUNICATIONS SYSTEMS CABLING AND EQUIPMENT.
- B. Contractors shall provide verification that they were Manufacturers Certification in good standing prior to project bid date.
 - 1. Temporary or short term certifications (less than the standard 12 month annual certification described above) or case-by-case certifications are not acceptable.
- C. **CONTRACTOR CERTIFICATION:** Contractor shall meet paragraph one below or paragraph one in combination with paragraph two and provide appropriate documentation in the 27 00 10 submittals:
 - 1. The Contractor shall have BICSI Registered Technicians and Installers on staff and assigned to this project. The project shall be staffed at all times by Technicians who, in the role of lead craft persons, will be able to provide leadership and technical resources for the remaining craft persons on the project.
 - a. The Contractor shall maintain under the supervision of a BICSI Technician a ratio of 2 BICSI Installer//non-certified helper.
 - b. Contractor shall provide BICSI certifications showing employee name, level, and expiration date. BICSI certificates of the highest level attained shall be submitted.
 - 2. The Contractor shall have employees on staff for the project who have completed the IBEW/NECA three-year Telecommunications Installer/Technician registered apprenticeship program.
 - a. The contractor shall maintain a ratio of 1 indentured Technician to 2 indentured apprentice/unindentured apprentice.
 - b. The contractor shall provide documentation verifying the indentured status of Apprentices and the Department of Labor Certificates of Completion for the Installer/Technicians.
 - 3. The contractor pulling the telecommunications cabling (if different from the prime Telecommunications Contractor) shall meet all the same BICSI or IBEW/NECA requirements, and requirements of this specification, as the prime Telecommunications Contractor.

- D. Contractor shall be located within 125 miles of the construction site to establish a potential two hour response time for ongoing customer needs after construction completion.

1.17 ACCEPTABLE MANUFACTURERS

- A. In most cases, equipment specifications are based on a specific manufacturer's type, style, dimensional data, catalog number, etc. Listed with the base specification, either in the manual or on the drawing schedules, are acceptable manufacturers approved to bid products of equal quality. These manufacturers are encouraged to submit to Design Professional at least 8 days prior to the bid due date drawings and catalog numbers of products to be bid as equals.
- B. Manufacturers, who do not submit prior to bidding, run the risk of having the product rejected at time of shop drawing submittal. Extra costs associated with replacing the rejected product shall be the responsibility of Contractor and/or the manufacturer.
- C. If Contractor chooses to use a manufacturer listed as an equal, it shall be their responsibility to assure that the manufacturer has complied with the requirements in 'A' above. Contractor shall assume all responsibility for physical dimensions, operating characteristics, and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of using the alternate manufacturer.
- D. Where a model or catalog number is provided, it may not be inclusive of all product requirements. Refer to additional requirements provided on the plans or in the specifications as required. Similarly, there may be additional requirements included in the model or catalog number that are not specifically stated. These requirements shall also be met.

1.18 QUALITY ASSURANCE

- A. Contractor shall be a company specializing in telecommunication cable and/or accessories with a minimum of five years documented experience in installation of cable and/or accessories similar to those specified below.

1.19 WARRANTY

- A. Refer to Divisions 00 and 01 for information on warranties and correction of work within the warranty period.
 - 1. If a warranty or warranty period are not defined in Division 00 or 01, then the start of all warranty periods shall be the date of Substantial Completion and the length of the warranty shall be for one year.
 - a. If construction is phased with distinct and separate Substantial Completion dates for portions of the building and/or systems, separate warranties shall be provided for each of these phased areas and/or systems.
 - b. All Division 27 systems, including all sub-systems, shall be guaranteed against defect in materials and installation for the duration of the warranty period. Any malfunctions or defects which occur within the warranty period shall be promptly corrected without cost to the Owner. This guarantee shall not limit or void any manufacturer's express or implied warranty.
- B. Refer to other Division 28 sections for systems, equipment, or material requiring extended warranties.
- C. The date of systems/equipment startup or equipment/material shipment to the site shall not be considered the notable date with relation to the warranty of that item. All systems, equipment, material, etc., shall have the same start date with respect to the warranty period.
- D. Systems, equipment or material put into use to facilitate construction activities (e.g. testing and balancing, commissioning, temporary conditioning, etc.) prior to the start of the warranty period shall not impact the length of the warranty in any way.

1.20 CHANGES IN THE WORK

- A. A Contract Change Order is a written order to Contractor signed by Owner and Contractor, issued after the execution of the Contract, authorizing a change in the Work or an adjustment in the Contract Sum or the Contract Time. The Contract Sum and the Contract Time may be changed only by Contract Change Order.
- B. Owner, without invalidating the Contract, may order changes in the Work within the general scope of the Contract consisting of additions, deletions or other revisions, with the Contract Sum and the Contract Time being adjusted accordingly. All such changes in the Work shall be authorized by Contract Change Order and shall be performed under the applicable conditions of the Contract Documents.
- C. The cost or credit to Owner resulting from a change in the Work shall be determined by mutual acceptance of a lump sum properly itemized and supported by sufficient substantial data to permit evaluation. Change Orders shall be submitted with each item listed individually with a material cost and labor unit extension. Overhead and profit, as mutually agreed upon between Owner and Contractor shall be added to material and labor cost figures.
- D. It shall be the responsibility of Contractor before proceeding with any change to satisfy their self that the change has been properly authorized on behalf of Owner.

1.21 GROUNDING AND BONDING OF SYSTEMS

- A. All low voltage systems shall be subject to the Telecommunications Grounding and Bonding specification section 27 1000. For those systems which may require a specialized sub-contractor, the sub-contractor providing and installing systems shall also be responsible for grounding and bonding per this specification.

1.22 COMPLETION

- A. Systems, at time of completion, shall be complete, efficiently operating, non-hazardous and ready for normal use by Owner.
- B. When all the work is complete Contractor shall thoroughly clean all material and equipment installed as a part of this contract and leave all equipment and material in new condition.
- C. Contractor shall clean up and remove from the site all debris, excess material and equipment left during the progress of this contract at job completion.

END OF SECTION 27 00 10

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**SECTION 27 05 26
GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 27 00 10 – Telecommunications General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

- A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this grounding and bonding system in compliance with the applicable standards, specifications and drawings. Contractor will provide and install all the required material to form a complete and operational system whether specifically addressed in the technical specifications or not.
- B. All division 27 low voltage systems shall adhere to these grounding and bonding requirements.
- C. Bond the following items within the telecommunications grounding system.
 - 1. All communications system active equipment.
 - 2. All POU and surge protection equipment.
 - 3. Raised floor systems.
 - 4. Underfloor grounding grids “supplemental bonding grids” for computer or telecommunications rooms.
 - 5. Metallic raceway systems, including metallic cable trays.
 - 6. Communications equipment enclosures (cabinets) or cross-connect frames.
 - 7. Broadband passive devices.
 - 8. Metallic splice cases.
 - 9. Metallic cable screens, armor or shields.
 - 10. All metal cable conduit.
 - 11. Electrical service panels in entrance facilities, telecommunications and equipment rooms.
 - 12. Wall and rack mounted grounding busbars.
 - 13. Exposed building steel that is within 6 feet of equipment racking systems.
 - 14. Building steel extending to earth in outside plant.
 - 15. All related bonding accessories.
- D. Quality Assurance:
 - 1. Grounding to conform to applicable building codes.
 - 2. Cable and equipment to be installed in a neat and workmanlike manner.
 - 3. Methods of construction that are not specifically described or indicated in the contract documents to be subject to the control and approval of the Owner representatives.
 - 4. Equipment and materials specified shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed.
 - 5. Where “approved equal” is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to written approval by the Design Professional and or Owner representative.
 - 6. Materials and Methods shall comply in every way with above cited Standards and Codes.

1.03 SUBMITTALS

- A. Submittal data for equipment, cabling, and hardware shall consist of catalog cuts showing technical data necessary to evaluate the materials with specific item designated by arrow or by being highlighted.

1.04 WORK BY OTHERS

- A. The Intersystem Grounding Busbar located outside the main electrical service equipment will be installed as part of the main electrical gear and connected back to the various building grounding sources (ground rods, water pipe, building steel, etc.).

1.05 FIRESTOPPING

- A. Contractor shall be responsible for fire stopping all conduit sleeves (internally only) and cable tray where required to maintain integrity of fire and/or smoke walls. The Contractor shall review architectural drawings to determine which walls have a fire and/or smoke rating. Any rating other than "non-rated" shall constitute a wall that requires fire stopping in all penetrations/openings.

PART 2 - PRODUCTS

2.01 GROUNDING AND BONDING PRODUCTS

- A. Grounding and Bonding bases of design products are Panduit. See this Spec Section 1.02 D.5 regarding approved equals.
- B. Acceptable Grounding and Bonding Components.
- C. Telecommunications Main Grounding Busbar (TMGB) consisting of twenty-four 1/4" stud holes with 5/8" spacing, and six 3/8" stud holes with 1" spacing.
 - 1. Panduit part number GB4B0624TPI-1.
- D. Telecommunications Grounding Busbar (TGB) consisting of twelve 1/4" stud holes with 5/8" hole spacing, and three 3/8" stud holes with 1" hole spacing.
 - 1. Panduit part number GB2B0312TPI-1.
- E. Busbar Label Kit Busbar label kit includes one printed tag and one flame retardant cable tie.
 - 1. Panduit part number LTYK.
- F. Data Rack Grounding Busbar, 19".
 - 1. Panduit part number RGRB19U.
- G. Server Cabinet Grounding Busbar, Cage-nut Mounting, 19".
 - 1. Panduit part number RGRB19CN.
- H. Bonding Backbone Splice Connectors: Irreversible Compression Splices C-TAPS
 - 1. Panduit part number CTAPG3/0-12-Q

2.02 GROUNDING CABLING

- A. The Intersystem Bonding Conductor (IBC) used for bonding the Intersystem Grounding Busbar to the Telecommunications Main Grounding Busbar (TMGB) shall be at a minimum, the same size as the largest TBB, green jacketed, stranded copper cable.
- B. The Telecommunication Bonding Backbone (TBB) used for bonding the Telecommunications Main Grounding Busbar (TMGB) to the Telecommunications Grounding Busbar (TGB) shall be a green jacketed, #3/0 AWG, stranded copper grounding cable.
 - 1. The TBB conductors shall be continuous and routed in the shortest possible straight-line path, avoiding changes in elevation and sharp bends.
 - 2. The TBB conductors shall be protected from mechanical damage and built to minimize splicing. Where splicing is required, they shall be done using irreversible compression splices (C-TAPS) built to that purpose. See the "Materials" section of this document for appropriate compression splices.
- C. The Equipment Bonding Conductor (EBC) used for bonding the TMGB or TGB to the data racks/server cabinets, any wall mounted low voltage system, the overhead cable tray system and to the electrical panel inside the telecom room inside the telecom room. The EBC shall be green jacketed #6 AWG stranded copper cable.
 - 1. The EBC is also used for bonding the TMGB or TGB to the primary cable tray outside the telecom room. The EBC shall be green jacketed #6 AWG stranded copper cable.
- D. The conductor used for bonding the TMGB or TGB to primary cable tray outside the telecom room shall be green jacketed #6 AWG stranded copper cable.

2.03 ADDITIONAL GROUNDING CABLING REQUIREMENTS

- A. Sizing the TBB conductor should follow the TIA-607-D bonding conductor sizing table. See the conductor sizing table below as published in the TIA-607-D

B. TIA-607-D Conductor Sizing Table.

TBC / TBB Linear Length m (ft)	Conductor Size (AWG)
Less than 4(13)	6
4-6 (14-20)	4
6-8 (21-26)	3
8-10 (27-33)	2
10-13 (34-41)	1
13-16 (42-52)	1/0
16-20 (53-66)	2/0
20-26 (67-84)	3/0
26-32 (85-105)	4/0
32-38 (106-125)	250 kcmil
38-46 (126-150)	300 kcmil
46-53 (151-175)	350 kcmil
53-76 (176-250)	500 kcmil
79-91 (251-300)	600 kcmil
Greater than 91 (301)	750 kcmil

2.04 GROUNDING HARDWARE

- A. Two Hole Lug, Code Conductor, Long Barrel with Window, AWG #3/0 3/8" with 1" spacing.
 - 1. Panduit part number LCC3/0-38DW-X or approved equal.
- B. Two Hole Lug, Code Conductor, Long Barrel with Window, AWG #1/0 3/8" with 1" spacing.
 - 1. Panduit part number LCC1/0-38DW-X or approved equal.
- C. Two Hole Lug, Code Conductor, Long Barrel with Window, AWG #6 with 5/8" spacing.
 - 1. Panduit part number LCC6-14AW-L or approved equal.
- D. Flex Conductor H-TAP's For splicing smaller conductors (pigtails) into larger continuous conductors.
 - 1. Panduit Part Number: HTCT Series: Taps must be selected according to AWG size.
 - a. H-TAP clear covers for H-TAP installations.
 - 1) Panduit Part Number: CLRCVR Series, must be selected according to the H-TAP being installed.
- E. C-TAP Splices for copper-to-copper splicing or pigtail tap splicing.
 - 1. Panduit Part Number: STAPF Series. Actual part number must be selected according to AWG size of conductors being spliced.
- F. Paint Piercing Grounding Washer Kit with Antioxidant: Panduit parts.
- G. Bonding Screws, #12-24: Panduit part number RGTBSG-C.
- H. Grounding lug for bonding wire basket tray. For Conductors #1/0AWG to #6AWG code conductors.
 - 1. Cablofil Part Number: GNDCL or approved equal.
- I. Equipment Bonding Jumper. Pre-terminated end attaches to grounding strip or grounding busbar, free end terminates to unique equipment terminations, C-TAP, H-TAP, Two Hole Lug etc.
 - 1. Panduit Part Number: CJS6120U

PART 3 - EXECUTION

3.01 STAR TOPOLOGY

- A. The telecom grounding and bonding system shall be provided and installed in a star topology.
 - 1. Each building shall receive one Telecommunications Main Grounding Busbar (TMGB) in the designated telecom room or utility demarcation area (see below for location), and one Telecommunications Grounding Busbar (TGB) in each additional telecom room or identified specialty location (see below for locations).

2. The TMGB shall receive a dedicated grounding connection back to the building Intersystem Grounding Busbar by Div.26. The building Intersystem Grounding Busbar is usually just outside the main electrical service gear (interior to the building, visible on the wall).
3. All TGB's shall receive a dedicated grounding connection back to the TMGB.

3.02 INSTALLATION AND LABELING

- A. Install bonding and grounding system cables and hardware as indicated in accordance with the manufacturer's written instruction, and recognized industry practices.
- B. Identify all bonding and grounding cables and hardware in the telecommunication room and field locations.
 1. Provide labeling per Div.27 05 53 Telecommunications Identification for Communications.

3.03 INTERSYSTEM GROUNDING BUSBAR LOCATION:

- A. See construction drawings and details for location.

3.04 TELECOMMUNICATIONS GROUNDING BUSBAR TMGB & TGB LOCATION:

- A. See construction drawings and details for TMGB & TGB locations.

3.05 TELECOMMUNICATIONS ROOM LADDER RACK

- A. All telecom room ladder rack shall be bonded together and to the telecommunications grounding busbar in that room.
- B. Bonding shall be accomplished per the following:
 1. Use the #6 AWG green jacketed cable listed in the cable paragraph.
 2. Use the #6 AWG two-hole lugs listed in the hardware paragraph.
 3. Use the bonding stud and bonding nuts listed in the hardware paragraph to secure the lug to the ladder rack.
 4. Drill holes in ladder rack to accommodate the two-hole lugs and bonding studs with bonding nuts.
 5. Install bonding conductors in a neat and orderly fashion so as not to droop or hang away from the material it is bonding.
 6. Use the #6 AWG two-hole lugs to bond to the busbar.

3.06 TELECOMMUNICATIONS ROOM RACKS AND CABINETS

- A. All telecom room racks and cabinets shall be individually bonded to the copper busbar in that room (the TMGB or TGB) using a dedicated cable installation.
- B. Grounding the rack or cabinet to the copper busbar shall be accomplished per the following:
 1. Use the #6 AWG green jacketed copper cable listed in the cable paragraph.
 2. Use the #6 AWG two-hole lugs listed in the hardware paragraph to connect to the telecom room grounding busbar.
 3. Use the #6 AWG two-hole lugs listed in the hardware paragraph to connect to the rack or cabinet grounding busbar.
 4. Use the paint piercing washers listed in the hardware paragraph.
 5. Install bonding conductors in a neat and orderly fashion so as not to droop or hang away from the material it is bonding.
 6. Use the #6 AWG two-hole lugs to bond to the busbar.

3.07 TELECOMMUNICATIONS CABLE TRAY AND/OR WIRE BASKET

- A. All installations of cable tray and/or wire basket runs shall be bonded to the nearest copper busbar in a telecom room (the TGB or TMGB) using #6 AWG green jacketed copper grounding conductor. The break point shall be at the same boundary as the UTP boundary between telecom rooms. Do not bond the cable tray or wire basket together across these boundaries as this could cause a grounding loop.
 1. All section of cable tray and/or wire basket shall be mechanically bonded together.
 - a. Sections of cable tray shall be bonded together with #6 AWG green copper grounding conductor and two-hole lugs referenced in this section 2.03.B or a cable tray manufactures bonding clamp and or UL rated basket tray connectors.

3.08 ELECTRICAL PANEL

- A. Bond TMGB and TGB to the local electrical panel that serves the room.
 - 1. See this spec. section 2.02.C for bonding conductor.
 - 2. Coordinate with the division 26 contractor for electrical panel connection.

END OF SECTION 27 05 26

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**SECTION 27 11 00
COMMUNICATIONS CABLING AND EQUIPMENT**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 27 00 10 – Telecommunications General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

- A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this structured cabling system in compliance with the specifications and drawings. Contractor will provide and install all of the required material to form a complete system whether specifically addressed in the technical specifications or not.

1.03 CODES AND STANDARDS

- A. All work shall be done in accordance with the applicable portion of the following codes and standards:
 1. National Electrical Code
 2. Local Electrical Code
 3. National Fire Protection Association
 4. National Electrical Manufacturers Association
 5. Standards of Institute of Electrical and Electronic Engineers
 6. Applicable Building Codes
 7. Occupational Safety and Health Act
 8. Iowa Administrative Codes
 9. ANSI TIA-526-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
 10. ANSI TIA-526-14-C Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
 11. ANSI TIA-568-C.0 Generic Telecommunications Cabling for Customer Premises
 12. ANSI TIA-568-C.1 Commercial Building Telecommunications Cabling Standard Part 1: General Requirements
 13. ANSI TIA-568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standards
 14. ANSI TIA-568-C.3 Optical Fiber Cabling Components Standard
 15. ANSI TIA-568-C.4 Broadband Coaxial Cabling and Components Standard
 16. ANSI TIA-569-D Telecommunications Pathways and Spaces
 17. ANSI TIA-570-C Residential Telecommunications Infrastructure Standard
 18. ANSI TIA-598-D Optical Fiber Cable Color Coding
 19. ANSI TIA-606-B Administration Standard for Commercial Telecommunications Infrastructure
 20. ANSI TIA-607-B Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
 21. ANSI TIA-758-B Customer-owned Outside Plant Telecommunications Infrastructure Standard
 22. National Fire Protection Agency (NFPA - 70), National Electrical Code (NEC)

1.04 SUBMITTALS

- A. Manufacturer and Contractor Certifications are required submittals in the division 27 General Provisions specifications section. The Manufacturer Certification is based on the material information listed below in the Acceptable Manufacturers paragraph.
- B. Submittal data for cabling and components shall consist of catalog cuts showing technical data necessary to evaluate the materials.

1.05 WORK BY OTHERS

- A. In general, the following is provided or is of note:
 - 1. Electrical Contractor will provide field device back boxes and conduit paths for use by Division 27 Contractors.
 - 2. The project painter may not be aware that ANY paint overspray (or direct application) of paint of any type to the UTP (unshielded twisted pair, generally called data cabling) voids the manufacturer's warranty and violates this specification. Paint may not be chemically or physically removed in any way once applied to the data cabling. Any cabling with paint overspray shall be fully replaced.

1.06 FIRESTOPPING

- A. Contractor shall be responsible for fire stopping all conduit sleeves (internally only) and cable tray where required to maintain integrity of fire and/or smoke walls. The Contractor shall review architectural drawings to determine which walls have a fire and/or smoke rating. Any rating other than "non-rated" shall constitute a wall that requires fire stopping in all penetrations/openings.

PART 2 - PRODUCTS

2.01 COPPER UTP CABLE AND CONNECTIVITY PRODUCTS

- A. Cabling and connectivity products (devices, cover plates, patch panels, insulation displacement connectors, etc.) must be part of a matched solution, provided by manufacturers that have been tested together and provide a fully certified end to end system.
- B. Acceptable Manufacturers:
 - 1. Panduit Mini-Com Cat6a UTP connectivity (flat, modular patch panels) w/ General GS10000 Cat6a cable with PanGenPlus 25-year system warranty provided by a Panduit Certified Installer.
 - 2. Cable Jacket Rating:
 - a. HHS Building
 - 1) Plenum
 - b. ADM & AME Buildings
 - 1) Non-Plenum

Note: If the above selection is not edited down to only one cable jacket type, the Contractor shall provide plenum rated cabling.

- C. Additional Cabling and Connectivity Requirements:
 - 1. Furnish and install cable between telecommunications room and field device locations as noted on the drawings.
 - 2. Each field jack shall have a dedicated cable.
 - 3. Provide cable terminations at telecommunications room.
 - 4. Provide terminations at all field locations with an 8 pin, 8 conductor (RJ45 type) modular jack and flush wall plate per drawings.
 - a. Telecom Room Jack Panduit Minicom Black:
 - b. Field Side Jack Panduit Minicom Artic White:
 - 5. Terminate using T568B wiring schematic unless noted otherwise.
 - 6. Provide wall faceplates from the same connectivity manufacturer per location requirements for all field devices.
 - 7. Faceplates shall be Panduit Minicom Classic series, Artic White.
 - 8. Confirm material and color of the electrical wiring device cover plates. See Spec. 26 27 26 Wiring Devices. If the electrical wiring device cover plate, material, and color conflict with the noted face plate and field side jack colors. Confirm with the design professional the appropriate spec to follow before ordering.
 - 9. Configure faceplate port quantities as required for individual field locations per drawings.
 - 10. Minicom bland inserts shall be installed in all empty jack locations.
 - 11. All patch panels shall be 48 ports in 2RU. Unless noted otherwise.

12. Occurrences of a single telecom room serving multiple floors.
 - a. The contractor shall refer to other spec sections and the project drawings for typical patch panel layouts and instructions if/when separation of patch panels per floor in the data rack will be required.
 - b. The contractor shall refer to other spec sections and project drawings for typical patch panel layouts and instructions if patch panel separation per floor isn't necessary.

2.02 WIRE BASKET HORIZONTAL CABLE MANAGEMENT

- A. Wire basket shall be provided and installed (generally outside of telecom rooms only) as shown on the plans.
- B. Acceptable Manufacturers are:
 1. Chatsworth Products (CPI), OnTrac Wire Mesh Cable Tray
 2. Wire Basket Tray (WBT) Shaped Wire Basket Tray
 3. Cooper B-Line, Flextray Cable Management
 4. Legrand Cablofil, Wire Mesh Cable Tray
 5. MonoSystems, Mono-Mesh Wire Basket Cable Tray
- C. Additional Wire Basket Requirements:
 1. All wire basket and hardware shall be galvanized (no other coatings) applied after product fabrication. This is to ensure a product that is made of an electrically conductive material for grounding purposes.
 2. It is the responsibility of the contractor installing the wire basket tray to coordinate the route indicated on the construction drawings with all other trades. Intersecting mechanical, fire alarm, or electrical systems shall not obstruct the fill ratio of the specified wire basket tray in any way.
 3. Whenever possible the Contractor shall continue the basket around corners and changes in elevation by applying the factory instructions for cutting and bending the material rather than stopping the material, forcing the cable to jump from one installation to the other.
 4. The Contractor shall only cut the material with manufacturer approved cutters which leave a square edge, rather than bolt cutters which leave a sharp edge that can damage cables and severely injure installers or the Owner in the future.
 5. Wire basket is shown in part diagrammatically on the plans. Conduit sleeves are shown passing through walls with a stub symbol on each end to represent what shall be installed.
 6. The Contractor shall install the wire basket at and to the intended locations shown on the plans.
 - a. The maximum air gap between wire basket and a conduit sleeve passing through a wall horizontally shall be one foot (12").
 - b. The maximum air gap between wire basket and the cable destination vertically shall be two feet (24").

2.03 LIGHTNING PROTECTION

- A. Lightning protection shall be provided for all cabling that does not remain fully inside the building envelope.
 1. All lightning protection provided for cabling that serves a network device shall be rated for 1GB data transmission speeds at a minimum and shall support Power Over Ethernet.
- B. Acceptable Manufacturers are:
 1. DITEK Surge Protection
 2. L-Com inc.
- C. Additional Lightning Protection Requirements:
 1. All cabling 25 pair or larger shall use an enclosed Building Entrance Terminal. This terminal shall be sized to accommodate all incoming cable pairs (full of 5 pin modules). Module selection shall be determined by the application chart found in manufacturer literature.
 2. For applications smaller than 25 pair, the proper manufacturer recommended solution is acceptable (enclosed or not).

2.04 FIRE ALARM PANEL CONNECTIONS

- A. Two fire alarm panel information drops shall be furnished and installed by Contractor for each fire alarm head end panel. These drops shall be provided when required, whether they are pictorially shown on the plans or not.
- B. Acceptable Manufacturers:
 - 1. UTP cabling shall be the same as the Contractor will be installing per paragraph 2.01.B of this specification.
 - 2. Terminate cabling on standard RJ45 modular Jacks and install in a 2-port surface mount housing from the cabling manufacturer noted per paragraph 2.01.B of the specification.

PART 3 - EXECUTION

3.01 UTP NO-PAINT WRITTEN NOTIFICATION REQUIREMENT

- A. Many painters do not know that paint overspray of any quantity on voice/data UTP cabling (called UTP from here on) voids the manufacturer's extended warranty required by the specification. The Telecom Contractor shall notify the General Contractor in writing that the UTP cannot be painted (not even the slightest bit of overspray) and inform him or her that mechanical or chemical removal of paint is not allowed but rather full replacement of any cable that has received any amount of paint or paint overspray shall be fully replaced (no splicing allowed). This notification shall occur at least 30 days prior to any UTP being installed in the facility or brought on-site for storage.

3.02 INSTALLATION AND LABELING

- A. Install telecommunication systems cables and auxiliary materials as indicated in accordance with manufacturer's written instructions, and recognized industry practices.
 - 1. In general, all interior cables are installed in conduit.
 - 2. D rings are allowed in telecommunications room as needed.
 - 3. Contractor shall use hook and loop type fasteners on all UTP telecommunications cable. Tie wraps may be temporarily used loosely for dressing UTP cables during installation if they are removed before final inspection. Any tie wrap found in place around UTP cable tight enough that a 0.5" wooden dowel cannot be inserted into the bundle at the tie wrap location shall therefore obligate the Contractor to replace those potentially damaged UTP cables at the Design Professionals discretion, whether they pass electronic testing or not.
 - 4. Tie wraps may be used carefully on OSP and armored cabling at light tension levels which do not result in any visible cable jacket deformation.
 - 5. If unarmored fiber is specified without innerduct for any reason, tie wraps are forbidden on that cabling.
 - 6. Any and all tie wraps used in the project shall be trimmed flush at the locking device using a fully flush cutter tool for safety. Any tie wrap found with a sharp point shall be removed by the Contractor and replaced without additional compensation.
- B. Identify all fiber, copper, and coaxial cables that terminate in the telecommunication room as to field location.
 - 1. Provide labeling per Div.27 05 53 Telecommunications Identification for Communications.
- C. After completion, all cables shall be thoroughly tested in accordance with the division 27 Testing and Documentation section.
 - 1. Contractor shall provide all instruments for testing the cables.
 - 2. Contractor shall demonstrate in the presence of Owner's representative that the telecommunications system is complete and operational.
 - 3. Contractor shall complete and submit the Certificate of System Demonstration.

- D. After completion, comprehensive CAD generated As-Builts will be created and posted in each Telecom Room within 3 days.
1. Two hard copies shall be created for each Telecom Room detailing the entire structured cabling plant and labeling scheme after installation. One hard copy shall consist of the Telecom plans that show the labeling used at each field location, and a table or spreadsheet (for example, an 8 ½" x 11" printed Excel file) that lists all the patch panel jacks in a column sequentially, followed by a cross reference column identifying the room name/number that the corresponding jack is in. This is the only part of the labeling process in which room name/numbers are acceptable. The second hard copy shall be identical to the first one. One copy shall be posted in each corresponding Telecom Room, and the other copy shall be submitted to the Design Professional for review according to the submittal process identified in the shop drawing paragraph of Specification Section 27 00 10. This second copy will then be forwarded to Owner.

END OF SECTION 27 11 00

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**SECTION 27 11 16
COMMUNICATIONS CABINETS, RACKS, FRAMES AND ENCLOSURES**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 27 00 10 – Telecommunications General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

- A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of all materials in compliance with the specifications, drawings, and manufacturer direction. Contractor will provide and install all the required material to form a complete system whether specifically addressed in the technical specifications or not.
- B. This section includes requirements for the following:
 - 1. Data Racks (DR)
 - 2. Data Cabinets (DC)
 - 3. Vertical Cable Managers (VCM)
 - 4. Horizontal Cable Manager (HCM)
 - 5. Overhead Horizontal Cable Tray (HBT, HLT)
 - 6. Wall Mounted Vertical Cable Tray (VBT, VLT)

1.03 SUBMITTALS

- A. Manufacturer and Contractor Certifications are required submittals in the Division 27 General Provisions specifications section. The Manufacturer Certification is based on the material information listed below in the Acceptable Manufacturers paragraph.
- B. Submittal data for cabinets, racks, frames, enclosures and required accessories shall consist of catalog cuts showing technical data necessary to evaluate the materials.

PART 2 - PRODUCTS

2.01 TELECOM ROOM EQUIPMENT

- A. Equipment room racks, cabinets, frames, and enclosures shall be an engineered manufactured product/solution. The engineered manufactured product/solution shall not be field modified without specific direction from the manufacturer as a part of the installation process.
 - B. Acceptable Manufacturers:
 - 1. Basis of design is Chatsworth products for all rack, cabinet, cable managers, frames and enclosure equipment listed in this section. The noted manufactures are acceptable when they have equivalent products or noted otherwise.
 - a. Panduit
 - 2. The acceptable manufactures are different for overhead and wall mounted wire basket tray and ladder rack. The acceptable manufacturers are noted in the particular equipment breakout sections of this specification.
- Additional Requirements:
- 3. All floor standing data racks shall support 19" EIA rack-mount equipment by universal threaded #12-24 equipment mounting holes unless noted otherwise.
 - 4. All floor standing 2 post data racks shall be constructed with standard 3" deep channels unless noted otherwise.
 - 5. All data racks, cabinet / enclosures, and vertical cable managers shall be black in color unless noted otherwise.
 - 6. All data racks shall have clearly marked and numbered RU's by the manufacturer for easy positioning of equipment.
 - 7. All floor standing data racks and vertical cable managers shall be 45 RU and 7' in height.

8. All exposed horizontal ladder rack ends shall be covered with manufacturer's rubber end caps.
 9. All horizontal ladder rack and/or wire basket tray shall be provided with the manufacturer's recommended fittings including but not limited to, splice clamps, end clamps, wall support brackets, floor support brackets, ceiling hanger brackets, end closing brackets, "L" brackets, wall angles, support clips, mounting angles, corner braces, junctions, factory manufactured angles, tees, crosses, connectors, auxiliary channel & rack to frame fasteners, cable rack to wall angle fasteners, auxiliary framing angles, auxiliary framing, hangers, elbows, end caps, hooks, threaded rod, and all other components to make the system work.
- C. Data Rack.
1. Plan Mark on Drawings: (DR)
 - a. Two Post, Aluminum, 3" Deep
 - 1) Chatsworth Standard Rack: 55053-703
 - a) Plan Mark DR-1
 - 2) Or equivalent acceptable manufacturer.
- D. Vertical Cable Manager
1. Plan Mark on Drawings: (VCM)
 - a. Double Sided, Combination W/1RU Cable Guide Fingers on the Front and Fold Down Arms on the back.
 - 1) Chatsworth Evolution 6" g3: 35571-703
 - a) Plan Mark VCM-6
 - 2) Chatsworth Evolution 10" g3: 35573-703
 - a) Plan Mark VCM-10
 - 3) Or equivalent acceptable manufacturer.
- E. Horizontal Cable Manager
1. Plan Mark on Drawings: (HCM)
 - a. Cable Guide Fingers with cover plate.
 - 1) Chatsworth Evolution 2RU: 35441-702
 - a) Plan Mark HCM-2
 - b) Or equivalent acceptable manufacturer.
- F. Overhead Horizontal Cable Tray within Equipment Room
1. Horizontal Wire Basket Tray. Plan Mark on Drawings: (HBT)
 - a. Wire Basket Tray, Clear, 12" Wide x 4" Deep
 - 1) Legrand Cablofil, Wire Mesh Cable Tray
 - 2) Cooper B-Line, Flextray Cable Management
 - a) Plan Mark HBT-12
- G. Wall Mounted Vertical Cable Tray within Equipment Room
1. Vertical Wire Basket Tray. Plan Mark on Drawings: (VBT)
 - a. Wire Basket Tray, Clear, 12" Wide x 4" Deep
 - 1) Legrand Cablofil, Wire Mesh Cable Tray
 - 2) Cooper B-Line, Flextray Cable Management
 - a) Plan Mark VBT-12

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install equipment room data racks and cable management as indicated in accordance with manufacturer's written instructions, recognized industry practices and project drawings.
1. Install as a complete system as indicated on the drawings.
 2. Install all ladder rack and/or wire basket tray free of sharp edges, burrs that can harm cable and or a person.

3. All horizontal cable managers, vertical cable managers and cable tray shall be installed level in the same plane as the walls and ceilings at the elevations and locations noted on the drawings.

END OF SECTION 27 11 00

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**SECTION 27 12 00
TELECOMMUNICATIONS TESTING AND DOCUMENTATION**

PART 1 - GENERAL

1.01 GENERAL

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

1.02 PURPOSE

- A. The purpose of the testing is to ensure proper installation of the telecommunications cabling system.

1.03 SUBMITTALS

- A. Submit product data under provisions of Division 1.
- B. Submit product data for the following:
 - 1. Hand-held testing equipment manufacturer, model, last calibration date/calibration due date and software version.
 - 2. Injector equipment manufacturer, model, and software version.

1.04 REFERENCES

- A. The following Performance Standards shall be followed. Unless otherwise stated, where Performance Standards conflict with manufacturer's recommendations, the more restrictive shall be applied:
 - 1. TIA-526-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
 - 2. TIA-526-14 Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
 - 3. TIA-568-C.0 Generic Telecommunications Cabling For Customer Premises
 - 4. TIA-568-C.1 Commercial Building Telecommunications Cabling Standard
 - 5. TIA-568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standards
 - 6. TIA-568-C.3 Optical Fiber Cabling Components Standard
 - 7. TIA-568-C.4 Broadband Coaxial Cabling and Components Standard

1.05 TEST EQUIPMENT

- A. Test Equipment: JDSU Certifier40G, Fluke DSX-5000, Fluke DTX-1800 or TIA & Connectivity Manufacturer approved Level IV (or better) Certifier.
- B. The software version for the testers shall be the latest version available.
- C. The tester must have been calibrated within the last 12 months with calibration date noted on all test results.

1.06 LINK DEFINITION FOR THE PROJECT

- A. A link consists of up to 90 meters (295 feet) of horizontal cabling, a connection at each end, up to 2 meters of test equipment lead from the main unit of the hand-held tester to the local connection, and up to 2 meters of test equipment lead from the remote unit to the remote connection. A total length of up to 94 meters (308 feet).
- B. The connection to the equipment at each end of the link is not included in the link definition.

1.07 CHANNEL DEFINITION FOR THE PROJECT

- A. A channel consists of up to 90 meters (295 feet) of horizontal cabling, a connection at each end, up to 7 meters for the cross-connect and equipment cable, and up to 3 meters for the work area equipment cable. A total length of up to 100 meters (328 feet).
- B. The connection to equipment at each end of the channel is not included in the channel definition.

PART 2 - COPPER CABLING ACCEPTANCE TESTING

2.01 ACCEPTANCE TESTS

- A. The following field acceptance tests shall be performed for twisted - pair cabling:
 - 1. Wire Map (continuity).
 - 2. Length.
 - 3. Attenuation.
 - 4. NEXT.
 - 5. ACR-F
 - 6. Delay and delay skew.
 - 7. Return loss.
 - 8. Power sum crosstalk (PSNEXT and PSACR-F).

2.02 TEST EQUIPMENT SET-UP AND TEST PARAMETERS

- A. Autotest: Use the Autotests to perform the required tests. Customize the Autotest as necessary to satisfy testing requirements and parameters.
- B. Cable Type: Select the cable type being tested. Cable Type may vary. Always change the NVP for the type of cable being tested.
- C. Frequency Range: The frequency range for category 5e tests shall be 1 MHz to 100 MHz.
- D. Frequency Range: The frequency range for category 6 tests shall be 1 MHz to 250 MHz.
- E. Frequency Range: The frequency range for category 6A tests shall be 1 MHz to 500 MHz.
- F. Cable Pairs: Test all cable pairs. Select all pairs for TEST and all pairs for Pass/Fail criteria for Autotest.
- G. Length Units: Cable length test results shall be in feet.
- H. Date Style. The date style shall show month, day, and year. Date shall be the date the test is conducted.
- I. Language: The language shall be English.

2.03 TEST PROCEDURE

- A. Testing shall be performed with the tester at the distribution frame and the remote unit at the Work Area Outlet.
- B. A Channel OR Permanent Link certification test will be performed as outlined in the specific job description.
- C. Test leads and test hardware have limited life-cycles. Inspect and replace the test leads as necessary.
- D. Use only test leads specified by the test equipment manufacturer.
- E. Strictly follow the test equipment manufacturer's instructions for equipment setup, initialization, and calibration.

PART 3 - MULTIMODE FIBER TESTING

3.01 ACCEPTABLE TESTS

- A. The following field acceptance tests shall be performed for multimode fiber:
 - 1. End to end attenuation & length testing at 850 nm and 1300 nm for backbone links.
 - 2. End to end attenuation & length testing at 850 nm and 1300 nm for horizontal links.
 - 3. Optical time domain reflectometer (OTDR) testing.

3.02 TEST PARAMETERS

- A. The following test parameters shall be adhered to:
 - 1. The transmit test port & test jumpers must be inspected and (if required) cleaned prior to testing. An image of the endfaces with endface condition pass/fail result must be included with the test report. Endface pass/fail conditions are outlined in TIA-568-C Annex E.

2. Fiber under test endfaces must be inspected and cleaned. An image with pass/fail criteria for endface condition must be included in the test results per TIA-568-C Annex E.
3. Test jumpers must be of the same fiber core size and connector type as the cable system (e.g., 50/125 um jumpers for a 50/125 um system).
4. As required in TIA-526-14, The testers must be referenced prior to testing by the one jumper method for Links and the three-jumper method for channels. The reference method preferred must be noted in the job specifications prior to testing.
5. The power meter and the light source must be set to the same wavelength.
6. The power meter must be calibrated and traceable to the National Institute for Standards and Technologies (NIST).
7. The light source or OTDR must operate within the range of 850+30 nm or 1300+20nm for multimode testing in accordance with ANSI/TIA/EIA-526-14.
8. All system connectors, adapters, and jumpers must be properly cleaned before measurements are taken.

PART 4 - SINGLEMODE FIBER TESTING

4.01 ACCEPTANCE TESTS

- A. The following field acceptance tests shall be performed for single mode fiber:
 1. End to end attenuation and length testing at 1310 nm and 1550 nm.
 2. Optical time domain reflectometer (OTDR) testing.

4.02 TEST PARAMETERS

- A. The following tests parameters shall be adhered to:
 1. The transmit test port & test jumpers must be inspected and (if required) cleaned prior to testing. An image of the endfaces with endface condition pass/fail result must be included with the test report. Endface pass/fail conditions are outlined in TIA-568-C Annex E.
 2. Fiber under test endfaces must be inspected and cleaned. An image with pass/fail criteria for endface condition must be included in the test results per TIA-568-C Annex E.
 3. Test jumpers must be of the same fiber core size and connector type as the cable system (e.g., singlemode jumpers for a singlemode system).
 4. As required in TIA-526-7, The testers must be referenced prior to testing by the one jumper method. The reference method preferred must be noted in the job specifications prior to testing.
 5. The power meter and the light source must be set to the same wavelength.
 6. The power meter must be calibrated and traceable to the National Institute for Standards and Technologies (NIST).
 7. The light source or OTDR must operate within the range of 1310+10 nm or 1550+20nm for singlemode testing in accordance with ANSI/TIA/EIA-526-7.
 8. All system connectors, adapters, and jumpers must be properly cleaned before measurements are taken.

PART 5 - MPO/MTP MULTIMODE FIBER TESTING

5.01 ACCEPTANCE TESTS

- A. The following field acceptance tests shall be performed for MPO/MTP Multimode fiber:
 1. End to end attenuation testing at 850 nm & fiber map.

5.02 TEST PARAMETERS

- A. The following tests parameters shall be adhered to:
 1. The transmit test port & test jumpers must be inspected and cleaned prior to testing. An image of the endfaces with endface condition pass/fail result must be included with the test report. Endface pass/fail conditions are outlined in TIA-568-C Annex E.
 2. Fiber under test endfaces must be inspected and cleaned. An image with pass/fail criteria for endface condition must be included in the test results per TIA-568-C Annex E.
 3. The tester must be referenced per the polarity type (Method A, B, C, or proprietary) of the system under test prior to testing.

4. The power meter and the light source must be set to the same wavelength.
5. The power meter must be calibrated and traceable to the National Institute for Standards and Technologies (NIST).
6. The light source must operate within the range of 850+30 nm for multimode testing in accordance with ANSI/TIA/EIA-526-14.

PART 6 - TESTING DOCUMENTATION

6.01 DOCUMENTATION

- A. The Test Documentation requirements are the minimum requirements. Other details of presentation and recording methods will be discussed with Owner and Design Professional. Gain approval from Owner and Design Professional of the test documentation format and content prior to full-scale testing. Coordinate with Owner and Design Professional to get representative sample of the documentation format and content for review.
- B. Provide Owner with a printed copy of ONLY the summary report of all tests, the electronic file of the test results for each test on CD or USB, and the electronic copy of the summary report on CD or USB. Do not print out each report.

6.02 TEST REPORT

- A. The following header fields on each test report shall contain the appropriate information. These are minimum requirements.
 1. Circuit ID
 2. Test Result
 3. Owner
 4. Test Equipment Serial Number
 5. Software Version
 6. Calibration Date
 7. Date
 8. Cable Type
 9. NVP
 10. Building
 11. Closet
- B. The information in each user definable header field on each test report shall contain the information as follows.
 1. Circuit ID: Indicate the outlet location number and jack number under test
 2. Owner: Indicate the owner of the test equipment
 3. Date: Indicate the date of the test
 4. Cable Type: Indicate the cable type being tested
 5. NVP: Indicate the field measured NVP
 6. Building: Indicate the building where the cable is being tested
 7. Closet: Indicate the closet identifier where the cable is terminated
- C. The minimum test result information on each report shall include the data for the tests identified in the Acceptance Tests paragraph of each applicable testing part.
- D. Contractor shall provide the test data in a complete and consistent format. Printed test results shall be printed from a laser printer.
- E. The contractor shall verify that a report for each jack in the Project is contained in the file list.
- F. Two weeks (14 days) prior to scheduled telecommunications systems start-up date Design Professional shall receive from Contractor complete printed cable performance test results via the submittal process (see 27 00 10). Start-up shall not commence unless test results are submitted.

6.03 ELECTRONIC COPY

- A. The electronic copy of the test results shall be on CD or USB.
- B. The electronic copy shall be labeled. The label shall read:

Project Name
building name (BLDG. No. x)
"Copper/Fiber Test Results"
"CD No." X of X
date (month and year)

- C. The files shall not be altered from the original test equipment output.

END OF SECTION 27 12 00

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SECTION 27 13 23
COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. This Section identifies the specification for optical fiber cable.

1.02 DESCRIPTION OF WORK

- A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this optical fiber cabling system in compliance with the specifications and drawings. Contractor will provide and install all the required material to form a complete system whether specifically addressed in the technical specifications or not.

1.03 REFERENCES

- A. Installation requirements are found in the following standards.
 - 1. ANSI/TIA-568-D Generic Telecommunications Cabling for Customer Premises.
 - 2. ANSI/TIA-569-E Telecommunications Pathways and Spaces
 - 3. ANSI/TIA-606-C Administration Standard for Telecommunication Infrastructure
 - 4. ANSI/TIA-526-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant.
 - 5. ANSI/TIA-526-14 Measurement of Optical Power Loss of Installed Multimode Fiber Cable Plant.
 - a. The Contractor is required to adhere to the current version of the standards at the time of construction.

1.04 SUBMITTALS

- A. Manufacturer and Contractor Certifications are required submittals in the division 27 General Provisions specifications section. The Manufacturer Certification is based on the material information listed below in the Acceptable Manufacturers paragraph.
- B. Submittal data for cabling and components shall consist of catalog cuts showing technical data necessary to evaluate the materials.

1.05 WORK BY OTHERS

- A. In general, the following is provided or is of note:
 - 1. Electrical Contractor will provide field conduit paths for use by the Telecom or other division 27 Contractor.

1.06 FIRESTOPPING

- A. Contractor shall be responsible for fire stopping all conduit sleeves (internally only) and cable tray where required to maintain integrity of fire and/or smoke walls. The Contractor shall review architectural drawings to determine which walls have a fire and/or smoke rating. Any rating other than "non-rated" shall constitute a wall that requires fire stopping in all penetrations/openings.

PART 2 - PRODUCTS

2.01 OPTICAL CABLE AND CONNECTIVITY PRODUCTS

- A. Cabling and connectivity products (splice/termination panels, fusion or mechanical field terminated splicing connectors, etc.) must be part of a matched solution, provided by manufacturers that have been tested together and provide a fully certified end to end system.
- B. Acceptable Manufacturers:
 - 1. Optical Fiber: Corning
 - a. Corning MIC Tight-Buffered, Cable, Single-Mode (OS2)
 - 1) 12 F, Single-Mode(OS2), Plenum: 012E88-33131-29
 - 2) 24 F, Single-Mode (OS2), Plenum: 024E88-33131-29

2. Fiber Housing: Corning
 - a. Corning Closet Connector Housing (CCH)
 - 1) 2RU, Rack Mountable, Closet Connector Housing, Holds Four CCH Connector Panels and or Splice Cassettes: CCH-02U
 - 2) 4RU, Rack Mountable, Closet Connector Housing, Holds Twelve CCH Connector Panels and or Splice Cassettes: CCH-04U
 3. Fiber Housing Connector Panel: Corning
 - a. Corning Closet Connector Housing (CCH) Panel
 - 1) (LC) Blue Adapter, Duplex, UPC, 12 F, Single-Mode (OS2), Duplex Panel: CCH-CP12-A9
 4. Optical Fiber Fusion Spliced Connector: Corning
 - a. Corning Closet Connector (CCH) Pigtailed Splice Cassette
CCH Pigtailed Splice Cassette, 12 F, LC UPC Duplex, Single-Mode (OS2): CCH-CS12-A9-P00RE
- C. Additional Cabling and Connectivity Requirements:
1. All optical fiber cables shall be home-run. Cables shall not be spliced.
 2. Furnish and install optical fiber between telecommunications room and field device locations as noted on the drawings.
 3. Provide optical fiber terminations at telecommunication rooms and or all field location as noted on the drawings using the note field termination connectors or fusion splice connectors.
 4. All optical fiber connector panels shall be configured with 6 LC duplex adapters to support 12 connectors.
 5. All incoming or outgoing building optical fiber shall be bonded using manufactured hardware and per the manufacturer's instructions.

PART 3 - EXECUTION

3.01 INSTALLATION AND LABELING

- A. Install optical fiber cables and associated hardware as indicated in accordance with manufacturer's written instructions, and recognized industry standards.
1. In general, interior optical fiber shall be installed in the noted existing or newly installed telecommunication primary pathways.
 2. All optical fiber cable shall have a minimum 20' service loop at both ends of the cables unless noted otherwise.
 3. Optical fiber cable service loops, unless note otherwise, shall be securely installed on the wall in the telecommunication rooms and clear of adjacent utilities or services in the room.
 4. Optical fiber cable service loops shall be completely accessible so that they can be extended if required.
 5. D rings are allowed in telecommunications room as needed to support and secure optical service loops to the wall.
 6. The contractor shall use hook and loop type fasteners on all optical fiber cable. Tie wraps may be temporarily used loosely for dressing optical fiber cables during installation only and shall be removed before final inspection.
 7. Tie wraps may be used carefully on armored OSP or in building cabling at light tension levels which do not result in any visible cable jacket deformation.
 8. If unarmored optical fiber cable is specified without innerduct for any reason, tie wraps are prohibited on that cabling.
 9. All tie wraps used in the project shall be trimmed flush at the locking device using a fully flush cutter tool for safety. Any tie wrap found with a sharp point shall be removed by the Contractor and replaced without additional compensation.
- B. Identify all optical fiber cables that terminate in the telecommunication room.
1. Contractor shall provide labels as specified in Section 27 05 53.

- C. After completion, all cables shall be thoroughly tested in accordance with the division 27 Testing and Documentation section.
 - 1. Contractor shall provide all instruments for testing the optical fiber cables.
 - 2. Contractor shall demonstrate in the presence of Owner's representative that the optical fiber system is complete and operational.
 - 3. Contractor shall complete and submit the Certificate of System Demonstration.

END OF SECTION 27 13 23

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**SECTION 27 45 00
SOUND MASKING SYSTEM**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The following requirements are applicable to work required of this section:
 - 1. Division 00 – Procurement, Contracting and Warranty Requirements
 - 2. Division 01 - General Requirements
 - 3. Section 26 05 29 – Hangers and Supports for Electrical Systems
 - 4. Section 26 05 33 – Raceways and Boxes for Electrical Systems
 - 5. Section 27 00 10 – Communications General Provisions.

1.02 DESCRIPTION OF WORK

- A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this Sound Masking system in compliance with the specifications and drawings. Contractor will provide and install all of the required material to form a complete system whether specifically addressed in the technical specifications or not.

1.03 SUBMITTALS

- A. Submittal data for Sound Masking cabling and components shall consist of:
 - 1. Catalog cuts showing technical product data necessary to evaluate the materials.
 - 2. Riser Diagram depicting intended signal flow.
 - 3. Floor plan indicating quantity, type, and location of components.

1.04 WORK BY OTHERS

- A. Unless noted otherwise, the building's Electrical Contractor will provide field device backboxes if needed, and conduit paths for use by Contractor.

1.05 FIRESTOPPING

- A. Contractor shall be responsible for firestopping all conduit sleeves and cable tray where required to maintain integrity of fire walls. Contractor shall see architectural drawings for walls that require fire rating.

1.06 ACCEPTABLE SOUND MASKING CONTRACTORS

- A. The contractor shall have the following qualifications:
 - 1. Factory qualified and certified to install products listed in Part 2 – Products
 - 2. Experienced in design, fabrication, installation, checkout, and warranty contract management of sound-masking systems.
 - 3. Versed in the provisions related to sound Masking systems of the following
 - a. NFPA 72
 - b. UL Chapter 24
 - c. American with Disabilities Act (ADA)
 - d. HIPPA (45 CFR, Parts 160 and 164)
- B. The contractor looking for a bid from the contractors listed above shall contact them as soon as possible to ensure they are aware of the project and have adequate time to prepare a bid. Two weeks should be considered a minimum.

PART 2 - PRODUCTS

2.01 SOUND MASKING SYSTEMS

- A. Sound Masking systems shall be provided with all applicable accessories as a system.
- B. Acceptable Manufacturers:
 - 1. Lencore
 - 2. Biamp Cambridge

3. LogiSon
4. Sound Management Group
- C. Additional Sound Masking System Requirements:
 1. The Sound Masking system shall be fully installed within manufacturer requirements and suggested guidelines.
 2. Adjust levels independently to minimum level between 40 and 50 dBA that will provide speech privacy between adjacent workstations while complying with other system requirements.
 3. Utilize structured cabling primary pathway for system cabling.
 4. Locate sound masking headend appliance in the main telecommunications closet. Coordinate location with 27 11 00 Contractor.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install Sound Masking systems cables, equipment, and auxiliary materials as indicated in accordance with manufacturer's written instructions, and recognized industry practices.
 1. Contractor shall use provided raceways or Contractor install J-hooks for all cabling. No fastening cabling to conduits, piping, equipment, or anything other than Contractor installed J-hooks.
 2. All Sound Masking cabling shall be home-run, no splicing.
- B. Identify all Sound Masking cables as to field location.
 1. Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type; either pre-numbered plastic-coated type, or write-on type with clear plastic self-adhesive cover flap; numbered to show cable identification. Install within 6" of cable end.
- C. After completion, all cables shall be thoroughly tested.
 1. Contractor shall provide all instruments for testing the cables.
 2. Contractor shall demonstrate in the presence of Owner's representative that the Sound Masking system is complete and operational.
 3. Contractor shall complete and submit the Certificate of System Demonstration.
- D. After completion, comprehensive As-Builts shall be created and provided to the design team for review.
 1. Two hard copies shall be provided to Owner detailing the entire Sound Masking system after installation. Each field position shall be labeled and cross referenced to the appropriate head end position for ease of troubleshooting.

3.02 COMMISSIONING

- A. The Contractor shall coordinate a date/time with the Engineer after the system is fully operational, but before final payment, for the Contractor to provide a full system demonstration. This shall include all aspects of system operation that the user might encounter.
- B. Operation and Maintenance Data:
 1. Provide as-built drawings of the system including schematics and floor plans indicating quantity, type, and location of components, cabling, and accessories.
 2. Operation and maintenance manuals.
 3. Provide warranty documentation, with start date(s) and service contract(s).
 4. Software and Firmware Operational Documentation:
 - a. Inventory of system components, with model and serial numbers for each.
 - b. Software operating and upgrade manuals.
 - c. Program Software and System Settings Backup: On digital media complete with data files. Provide electronic backup file of all system settings.
 - d. Device address list.
 - e. Printout of software application and graphic screens.
 - f. Provide login ID and password(s) to access control functions on the graphical user interface, if applicable.

END OF SECTION 27 45 00

**SECTION 27 50 00
PAGING SYSTEM**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 27 00 10 – Telecommunications General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

- A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this paging system in compliance with the specifications and drawings. Contractor will provide and install all of the required material to form a complete system whether specifically addressed in the technical specifications or not.

1.03 SUBMITTALS

- A. Submittal data for paging cabling and components shall consist of catalog cuts showing technical data necessary to evaluate the materials.

1.04 WORK BY OTHERS

- A. Unless noted otherwise, the building's Electrical Contractor will provide field device backboxes if needed, and conduit paths for use by Contractor.

1.05 FIRESTOPPING

- A. Contractor shall be responsible for firestopping all conduit sleeves and cable tray where required to maintain integrity of fire walls. Contractor shall see architectural drawings for walls that require fire rating.

1.06 ACCEPTABLE PAGING CONTRACTORS

- A. The contractor shall be one of the following:
 - 1. The Contractor shall be a manufacturer authorized dealer in good standing (for at least six months before project bid date with verifiable documentation) for the products listed below in 2.01.B, ACCEPTABLE MANUFACTURERS.

PART 2 - PRODUCTS

2.01 PAGING SYSTEMS

- A. Paging systems shall be provided with all applicable accessories as a system.
- B. Acceptable Manufacturers:
 - 1. Valcom: Paging Controller
 - 2. Valcom: Universal Paging Interface SIP to Analog
 - 3. Valcom: Powered, Amplified Ceiling Speaker
 - 4. Ortronics: Mod 8 Patch Panel
 - 5. General Cable: GenSpeed 5000, Cat.5e Cable
 - a. Cable Jacket
 - 1) Plenum for the HHS building
 - 2) Non-Plenum for the ADM
- C. Additional Paging System Requirements:
 - 1. The paging system will connect to the Owners IP phone system.
 - 2. Paging speakers are in common areas only. Not office suits, private offices, or conference/meeting/training rooms. All speakers will be configured as one zone.

2.02 PAGING SYSTEMS EQUIPMENT

- A. Paging systems shall be provided with all applicable accessories as a system.
- B. See the technology paging system schedule on the construction documents for equipment specifics and part numbers.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install Paging systems cables, equipment, and auxiliary materials as indicated in accordance with manufacturer's written instructions, and recognized industry practices.
 - 1. Contractor shall use hook and loop type fasteners on all paging cable. Tie wraps shall not be used.
 - 2. Contractor shall use provided raceways or Contractor install J-hooks for all cabling. No fastening cabling to conduits, piping, equipment, or anything other than Contractor installed J-hooks.
 - 3. All paging cabling shall be homerun, no splicing.
 - a. Daisy chaining cable is acceptable for the paging system if it is a installation recommendation by Valcom.
- B. Identify all paging cables as to field location.
 - 1. Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type; either pre-numbered plastic-coated type or write-on type with clear plastic self-adhesive cover flap; numbered to show cable identification. Install within 6" of cable end.
- C. After completion, all cables shall be thoroughly tested.
 - 1. Contractor shall provide all instruments for testing the cables.
 - 2. Contractor shall demonstrate in the presence of Owner's representative that the paging system is complete and operational.
 - 3. Contractor shall complete and submit the Certificate of System Demonstration.
- D. After completion, comprehensive As-Builts will be created and provided to Owner within 3 days.
 - 1. Two hard copies shall be provided to Owner detailing the entire paging system after installation. Each field position shall be labeled and cross referenced to the appropriate head end position for ease of troubleshooting.

3.02 COMMISSIONING

- A. The Contractor shall coordinate a date/time with the Engineer after the system is fully operational, but before final payment, for the Contractor to provide a full system demonstration. This shall include all aspects of system operation that the user might encounter.

END OF SECTION 27 50 00

**SECTION 28 00 10
ELECTRONIC SAFETY AND SECURITY GENERAL PROVISIONS**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 DESCRIPTION OF WORK

- A. This section applies to all work under this division. This shall include, but not necessarily be limited to, the following:
 - 1. Furnish, install, and terminate all system equipment and cabling as applicable and per drawings.
 - 2. Furnish and install any cabinets, racks and cable management as required and as indicated.
 - 3. Furnish any other material required to form a complete and operational system.
 - 4. Provide As-Built drawings per Division 0 and/or Division 1 specification.
 - 5. Provide Owner training and testing documentation.
 - 6. All elements of the construction shall be performed by workmen skilled in the particular craft involved, and regularly employed in that particular craft.
 - 7. All work shall be performed in a neat, professional manner in keeping with the highest standards of the craft.

1.03 CODES AND STANDARDS

- A. All work shall be done in accordance with the applicable portion of the following codes and standards:
 - 1. National Electrical Code
 - 2. Local Electrical Code
 - 3. National Fire Protection Association
 - 4. National Electrical Manufacturers Association
 - 5. Standards of Institute of Electrical and Electronic Engineers
 - 6. Applicable Building Codes
 - 7. Occupational Safety and Health Act
 - 8. Iowa Administrative Codes
 - 9. ANSI TIA-526-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
 - 10. ANSI TIA-526-14-C Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
 - 11. ANSI TIA-568-C.0 Generic Telecommunications Cabling For Customer Premises
 - 12. ANSI TIA-568-C.1 Commercial Building Telecommunications Cabling Standard Part 1: General Requirements
 - 13. ANSI TIA-568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standards
 - 14. ANSI TIA-568-C.3 Optical Fiber Cabling Components Standard
 - 15. ANSI TIA-568-C.4 Broadband Coaxial Cabling and Components Standard
 - 16. ANSI TIA-569-D Telecommunications Pathways and Spaces
 - 17. ANSI TIA-570-C Residential Telecommunications Infrastructure Standard
 - 18. ANSI TIA-598-D Optical Fiber Cable Color Coding
 - 19. ANSI TIA-606-B Administration Standard for Commercial Telecommunications Infrastructure
 - 20. ANSI TIA-607-B Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
 - 21. ANSI TIA-758-B Customer-owned Outside Plant Telecommunications Infrastructure Standard
 - 22. National Fire Protection Agency (NFPA - 70), National Electrical Code (NEC)

- B. All Contractors shall familiarize themselves with all codes and standards applicable to their work. No extra compensation will be allowed for corrections or changes in the work required due to failure to comply with the applicable codes and standards. Where two or more codes or standards are in conflict, that requiring the highest order of professionalism shall take precedence, but such questions shall be referred to Design Professional for final decision.

1.04 REQUIREMENTS & FEES OF REGULATORY AGENCIES

- A. Contractor shall comply with the rules and regulations of the local serving utility companies and shall check with each utility company providing service to this project and determine or verify their requirements regarding incoming services.
- B. Secure and pay for all permits, licenses, fees and inspections.

1.05 DRAWINGS

- A. Drawings for the work are in part diagrammatic, and are intended to convey the scope of the work and to indicate in general the location of equipment.
- B. Contractor shall layout their own work and shall be responsible for determining the exact quantities and locations for equipment.
- C. Contractor shall take own field measurements for verifying locations and dimensions; scaling of the drawings will not be sufficient for laying out the work.
- D. Because of the scale of the drawings, certain basic items for a complete installation are not shown, but where such items are required by code or where they are required for proper installation and operation of the work, such items shall be furnished and installed.

1.06 ACTIVE SERVICES

- A. Contractor shall be responsible for verifying exact locations of all existing services prior to beginning work in that area.
- B. When active services are encountered which require relocation, Contractor shall make request to authorities with jurisdiction for determination of procedures.
- C. Where existing services are to be abandoned, they shall be terminated in conformance with requirements of the authorities having jurisdiction.

1.07 SITE INSPECTION

- A. Contractor shall inspect the site prior to submitting bid for work to become familiar with the conditions of the site which will affect the work and shall verify points of connection with utilities and/or existing system wiring.
- B. Extra payment will not be allowed for changes in the work required because of Contractor's failure to make this inspection.

1.08 COORDINATION AND COOPERATION

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

- C. Conflicts between the drawings and the specifications, or between the requirements set forth for the various divisions shall be called to the attention of the Design Professional. If clarification is not asked for prior to the taking of bids, it will be assumed that none is required and that the Contractor is in agreement with the drawings and specifications as issued. If clarification is required after the contract is awarded, such clarification will be made by the Design Professional and the decision will be final.
- D. Special care shall be taken for protection for all equipment. All equipment and material shall be completely protected from weather elements, painting, plaster, etc., until the project is substantially completed. Damage from rust, paint, scratches, etc., shall be repaired as required to restore equipment to original condition.
- E. Protection of all equipment during the painting of the building shall be the responsibility of the Painting Contractor, but this shall not relieve the Contractor of the responsibility for checking to assure that adequate protection is being provided.
- F. Where the final installation or connection of equipment in the building requires the Contractor to work in areas previously finished by the Owner, the Contractor shall be responsible that such areas are protected and are not marred, soiled or otherwise damaged during the course of such work. Contractor shall be responsible for patching and refinishing of such areas which may be damaged in this respect.
- G. Where two or more specified items/systems in the specifications and/or the drawings are in conflict, that requiring the highest order of professionalism and the most financially expensive products shall take precedence. Such questions shall be referred to the Design Professional for final decision.

1.09 MATERIALS AND EQUIPMENT

- A. All materials and equipment shall be the standard product of a reputable manufacturer regularly engaged in the manufacture of the specified item unless authorized in writing by Design Professional. Where more than one unit is required of the same items, they shall be furnished by the same manufacturer except where specified otherwise.
- B. All material and equipment shall be installed in strict accordance with the manufacturer's recommendations.
- C. The equipment specifications cannot deal individually with any minute items such as parts, controls, devices, etc., which may be required to produce the equipment performance and function as specified, or as required to meet the equipment guarantees. Such items when required shall be furnished as part of the equipment, whether or not specifically called for.

1.10 SUBMITTALS

- A. Contractor shall furnish, to the Design Professional, complete sets of shop drawings and other submittal data. Contractor shall review and sign shop drawings before submittal. Refer to Division 01 specifications for additional requirements
- B. Shop drawings shall be bound into sets and cover related items for a complete system as much as practical and shall be identified with symbols or "plan marks" used on drawings. Incomplete, piecemeal or unbound submittals will be rejected.
- C. The Design Professional will review shop drawings solely to assist contractors in correctly interpreting the plans and specifications.
- D. Contract requirements cannot be changed by shop drawings which differ from contract drawings and specifications.
- E. Submittals required by the various sections of the Project Manual include, but are not necessarily limited to those identified in the submittal schedule below.
- F. After award of contract, the contractor shall provide a completed submittal schedule including dates that the submittals will be to the Design Professional for review.

G. Submit required information on the following items:

SPEC SECTION	EQUIPMENT	DETAIL DWGS	PROD DATA	SAMPLES	INSTALL METHODS	O & M MANUAL	CERTIFICATE OF SYSTEM DEMONSTRATION	OTHER (SEE NOTES)
28 31 00	Fire Alarm and Detection Systems	X	X		X	X		
28 40 00	Emergency Two Way Communication System	X	X			X	X	
28 50 00	Access Control	X	X			X	X	
28 60 00	Video Surveillance System	X	X			X	X	
28 70 00	Intrusion Detection System	X	X			X	X	
28 80 00	Distributed Antenna System	X	X			X	X	
Notes:								

1.11 OPERATION AND MAINTENANCE MANUALS

- A. Operation and maintenance manuals shall be submitted to the Design Professional in duplicate upon completion of the job. Refer to Division 01 specifications for additional information.
- B. Submit manuals in duplicate upon completion of the job. Manuals shall be bound in a three-ring hard backed binder. Front cover and spine of each binder shall have the following lettering done:

OPERATION
AND
MAINTENANCE
MANUAL
FOR
TELECOMMUNICATIONS SYSTEMS

(PROJECT NAME)
(LOCATION)
(DATE)

SUBMITTED BY
(NAME, ADDRESS AND PHONE NUMBER OF CONTRACTOR)

- C. Provide a master index at the beginning of manual showing items included. Each section shall contain the following information for equipment furnished under this contract:
 - 1. Equipment and system warranties and guarantees.
 - 2. Installation instructions.
 - 3. Operating instructions.
 - 4. Maintenance instructions.
 - 5. Spare parts identification and ordering list.
 - 6. Local service organization, address, contact and phone number.
 - 7. Shop drawings with reviewed stamp of Design Professional and Contractor shall be included, if applicable, along with the items listed above.

1.12 TESTS AND DEMONSTRATIONS

- A. All systems shall be tested by the Contractor and placed in proper working order prior to demonstrating systems to Owner.

1.13 TRAINING AND DEMONSTRATIONS

- A. Prior to acceptance of the telecommunications installation, the Contractor shall provide to the Owner, or their designated representatives, all comprehensive training on essential features and functions of all systems installed, and shall instruct the Owner in the proper operation and maintenance of such systems.
 - 1. Provide adequate notice to the Owner as to when instruction will be conducted so appropriate personnel can be present.
 - 2. Prepare the instruction format for a minimum of four Owner Representatives.
- B. Equipment training:
 - 1. Manufacturer's representatives shall provide instruction on each major piece of equipment. The Contractor shall provide instruction on all other equipment.
 - 2. Training sessions shall use the printed installation, operation and maintenance instruction materials included in the O&M manuals and emphasize preventative maintenance and safe operating procedures.
 - 3. Training shall be performed by qualified factory trained technicians.
 - 4. The Contractor shall attend all sessions performed by the manufacturer's representative and shall add to each session any special information relating to the details of installation of the equipment as it might impact the operation and maintenance.
 - 5. Equipment training shall occur as soon as possible after start up of the equipment and shall include hands-on operation. Training shall be provided for equipment listed in the table below.
- C. System training:
 - 1. Training sessions shall include hands-on demonstrations of system wide start-up, operation in all possible modes, shut-down and emergency procedures.
- D. The following are minimum requirements for Owner instruction:

Section	Description	Hrs. on Site	Hrs. off Site	Presented By	Others Present	Remarks
28 31 00	Fire Alarm and Detection Systems	4	0	Manufacturer's Representative	Contractor	1
28 40 00	Emergency Two Way Communication System	2	0	Installing Contractor	Owner	1
28 50 00	Access Control	4	0	Access Control Contractor	Owner	1
28 60 00	Video Surveillance	4	0	Video Surveillance Contractor	Owner	1
28 70 00	Intrusion Detection System	4	0	Intrusion Detection Contractor	Owner	1
28 80 00	Distributed Antenna System	2	0	DAS Contractor	Owner	1

Remarks:
 1. Perform complete system test at time of instruction.

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

CERTIFICATE OF SYSTEM DEMONSTRATION

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

- A. Project:
- B. System(s):
- C. Contractor's representatives giving instruction and demonstration:

Contractor: _____

NAMES	DATE	HOURS

- D. Owner's representatives receiving instruction:

Owner: _____

NAMES	DATE	HOURS

- E. Acknowledgement of demonstration:

Contractor's Representative:

Signature

date

Owner's Representative:

signature

date

1.14 PERMITS, FEES, ETC.

- A. Secure all required permits and pay for all inspections required in connection with the telecommunication systems work. Contractor shall post all bonds and obtain all licenses required by the State, City, County, and Federal Agencies.

1.15 SUBSTITUTIONS

- A. To obtain approval to use unspecified equipment, Bidding Contractors (not equipment supplier, manufacturers, etc.) shall submit written requests to the Design Professional at least 10 days prior to bid due date. Requests shall clearly describe the equipment for which approval is being requested. Include all data necessary to demonstrate that equipment's capacities, features and performance are equivalent to include a cost comparison between specified equipment and equipment for which approval is being requested. If the equipment is acceptable, the Design Professional will approve it in an addendum. The Design Professional will, under no circumstances, be required to prove that an item proposed for substitution is or is not of equal quality to the specified item.
- B. Where substitutions are approved, Contractor assumes all responsibility for physical dimensions and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of the substitution.

1.16 APPROVED CONTRACTORS

- A. The Contractor shall be a manufacturer certified installer and service provider for the product submitted and installed. A copy of the Contractor's manufacturer certification must be submitted under this specification section for the Access Control Contractor and the Video Surveillance Contractor if applicable to the project. The Contractor is responsible for professional and installation practices in accordance with the manufacturer requirements and must be authorized to provide a Manufacturer's Product Warranty with their installation.
- B. The Contractor pulling the cabling (if different from the prime system Contractor) shall meet the BICSI or IBEW/NECA requirements found in the Division 27 General Provisions.
- C. Contractor shall be located within 125 miles of the construction site to establish a potential two-hour response time for ongoing customer needs after construction completion.

1.17 ACCEPTABLE MANUFACTURERS

- A. In most cases, equipment specifications are based on a specific manufacturer's type, style, dimensional data, catalog number, etc. Listed with the base specification, either in the manual or on the plans are acceptable manufacturers approved to bid products of equal quality. These manufacturers are encouraged to submit to the Design Professional at least 8 days prior to the bid due date drawings and catalog numbers of products to be bid as equals.
- B. Manufacturers who do not submit prior to bidding run the risk of having the product rejected at time of shop drawing submittal. Extra costs associated with replacing the rejected product shall be the responsibility of the Contractor and/or the manufacturer.
- C. If the Contractor chooses to use a manufacturer listed as an equal, it shall be their responsibility to assure that the manufacturer has complied with the requirements in 'A' above. Contractor shall assume all responsibility for physical dimensions, operating characteristics, and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of using the alternate manufacturer.
- D. Where a model or catalog number is provided, it may not be inclusive of all product requirements. Refer to additional requirements provided on the plans or in the specifications as required. Similarly, there may be additional requirements included in the model or catalog number that are not specifically stated. These requirements shall also be met.

1.18 QUALITY ASSURANCE

- A. The Contractor shall be a company specializing in telecommunication cable and/or accessories with a minimum of five years documented experience in installation of cable and/or accessories similar to those specified below.

1.19 WARRANTY

- A. Refer to Divisions 00 and 01 for information on warranties and correction of work within the warranty period.
 - 1. If a warranty or warranty period are not defined in Division 00 or 01, then the start of all warranty periods shall be the date of Substantial Completion and the length of the warranty shall be for one year.
 - a. If construction is phased with distinct and separate Substantial Completion dates for portions of the building and/or systems, separate warranties shall be provided for each of these phased areas and/or systems.
 - b. All Division 28 systems, including all sub-systems, shall be guaranteed against defect in materials and installation for the duration of the warranty period. Any malfunctions or defects which occur within the warranty period shall be promptly corrected without cost to the Owner. This guarantee shall not limit or void any manufacturer's express or implied warranty.
- B. Refer to other Division 28 sections for systems, equipment, or material requiring extended warranties.
- C. The date of systems/equipment startup or equipment/material shipment to the site shall not be considered the notable date with relation to the warranty of that item. All systems, equipment, material, etc., shall have the same start date with respect to the warranty period.
- D. Systems, equipment or material put into use to facilitate construction activities (e.g. testing and balancing, commissioning, temporary conditioning, etc.) prior to the start of the warranty period shall not impact the length of the warranty in any way.

1.20 CHANGES IN THE WORK

- A. A Contract Change Order is a written order to the Contractor signed by the Owner and Contractor, issued after the execution of the Contract, authorizing a change in the Work or an adjustment in the Contract Sum or the Contract Time. The Contract Sum and the Contract Time may be changed only by Contract Change Order.
- B. The Owner, without invalidating the Contract, may order changes in the Work within the general scope of the Contract consisting of additions, deletions or other revisions, with the Contract Sum and the Contract Time being adjusted accordingly. All such changes in the Work shall be authorized by Contract Change Order and shall be performed under the applicable conditions of the Contract Documents.
- C. The cost or credit to the Owner resulting from a change in the Work shall be determined by mutual acceptance of a lump sum properly itemized and supported by sufficient substantial data to permit evaluation. Change Orders shall be submitted with each item listed individually with a material cost and labor unit extension. Overhead and profit, as mutually agreed upon between Owner and Contractor shall be added to material and labor cost figures.
- D. It shall be the responsibility of the Contractor before proceeding with any change to satisfy themselves that the change has been properly authorized on behalf of the Owner.

1.21 COMPLETION

- A. Systems, at time of completion, shall be complete, efficiently operating, non-hazardous and ready for normal use by the Owner.
- B. When all the work is complete the Contractor shall thoroughly clean all material and equipment installed as a part of this contract and leave all equipment and material in new condition.
- C. The Contractor shall clean up and remove from the site all debris, excess material and equipment left during the progress of this contract at job completion.

END OF SECTION 28 00 10

SECTION 28 26 26
ELECTRONIC EMERGENCY 2-WAY COMMUNICATION SYSTEM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The requirements of the following Divisions:
 - 1. Division 00 – Procurement, Contracting and Warranty Requirements
 - 2. Division 01 - General Requirements
 - 3. Section 27 00 10 – Communications General Provisions
 - 4. Section 27 11 00 – Communication Cabling and Equipment

1.02 DESCRIPTION OF WORK

- A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this IP 2-way emergency communication signal system designed ADA (Americans with Disabilities Act) requirements. This work shall include a main control panel capable of supporting a minimum of 48 zones, optional or as needed remote-control panels, distribution module, remote call stations, uninterruptable power supply (UPS), UPS monitoring module, IP Supervisor outlet boxes, cables, and wiring as shown on the drawings and as specified herein.

1.03 SUBMITTALS

- A. Submittal data for communication system cabling and components shall consist of product data sheets showing technical specifications necessary to evaluate the materials.
- B. Submit shop drawings showing layout, profiles, and product components, including anchorage and accessories. Include cabling diagrams, wiring diagrams, station installation details, and equipment cabinet details.
- C. Submit certified test reports showing compliance with specified performance characteristics.

1.04 WORK BY OTHERS

- A. Unless noted otherwise, the Division 26 Contractor will provide field device back boxes and conduit paths for use by Division 27 and Division 28 Contractors.
- B. All horizontal cabling from the telecom room to all system component locations for the purpose of delivering data/IP service to that component is by the Division 27 11 00 Contractor.

1.05 FIRESTOPPING

- A. Contractor shall be responsible for firestopping all conduit sleeves and cable tray where required to maintain integrity of fire walls. Contractor shall see architectural drawings for walls that require fire rating.

1.06 ACCEPTABLE EMERGENCY COMMUNICATION SYSTEM CONTRACTORS

- A. The following contractors are pre-approved to bid this project:
 - 1. The Contractor shall be a manufacturer authorized dealer in good standing (for at least six months before project bid date with verifiable documentation) for the products listed below in 2.01.C, ACCEPTABLE MANUFACTURERS.

PART 2 - PRODUCTS

2.01 EMERGENCY COMMUNICATION SYSTEM

- A. Emergency communication system shall be provided with all applicable accessories as a system.
- B. Acceptable Manufacturers:
 - 1. Rath: IP Command Center. Basis of Design
 - a. Base Station
 - b. Distribution module

- c. Call Boxes
 - d. Signage
 - 2. Code Blue
- C. Product Substitutions:
 - 1. No substitutions permitted.
- D. System Components:
 - 1. Base Station
- E. Sub-Base Stations as required
 - 1. Call Box
 - a. Multiple Call Boxes as required.
 - 2. Distribution Module
 - 3. Uninterruptable Power Supply (UPS)
 - 4. UPS Monitor
 - a. Capable of sending power failure notice to addressable fire alarm module.
 - 5. IP Supervisor
 - a. Capable of sending system IP communication failure to addressable fire alarm module.
 - 6. Signage
 - a. Provide all signage consisting of multiple types as required by code.
- F. Additional Requirements:
 - 1. Division 28 shall provide a fully supervised, two-way voice communication system between each call station and the main control panel capable of external alarm notification and two-way voice communication to a 24/7 emergency monitoring service.
 - 2. The system shall be full duplex VoIP using SIP standards.
 - 3. The system shall poll (supervise) all the call stations, control panels and field switches on a continuous basis at least every 200 seconds to identify line faults and defective equipment. Faults will be alerted and displayed at the control panel(s).
 - 4. Division 28 shall provide 24/7/365 electrical power to the system. The system shall not need or accept a fire alarm system activation signal to be operational; it shall always be operational no matter the status of the fire alarm system.
 - 5. Division 28 shall provide the Division 26 Contractor any proprietary back boxes at least two weeks before rough-in time.
 - 6. To program the main control panel for external communication, Division 28 shall initiate and coordinate available phone numbers and/or SIP information with the Owner for programming.
 - 7. Division 28 shall provide code required signage on the wall at every call station installed on the project.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install the emergency communication system cables, equipment, and auxiliary materials as indicated in accordance with manufacturer's written instructions and recognized industry practices.
 - 1. Division 27 Contractor shall install cabling in conduit provided by Division 26 Contractor.
 - 2. All emergency communication signal system cabling shall be homerun, no splicing, and in accordance with the manufacturer's wiring diagrams.
 - 3. All wiring shall test free from grounds and shorts.
- B. Identify all emergency communication signal system cables as to field location.
 - 1. Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type; either pre-numbered plastic-coated type or write-on type with clear plastic self-adhesive cover flap; numbered to show cable identification. Install within 6" of cable end.

- C. After completion, the system shall be thoroughly tested.
 - 1. Contractor shall demonstrate in the presence of Owner's representative that the emergency two-way communication signal system is complete and operational.
 - 2. Contractor shall complete and submit the Certificate of System Demonstration.
- D. After completion, comprehensive As-Builts will be created and provided to Owner within 10 days.
 - 1. Two hard copies shall be provided to Owner detailing the entire emergency two-way communication signal system after installation. Each field position shall be labeled and cross referenced to the appropriate head end position for ease of troubleshooting.

3.02 COMMISSIONING

- A. The contractor shall initiate and coordinate a time with the Owner and Engineer for a complete system demonstration after final installation. The demonstration shall include end-to-end two-way communication from all call stations to the master call station and the remote monitoring agency. A return call from the monitoring agency to the two-way voice communication call stations will be a part of the demonstration.
 - 1. Notify the monitoring agency or local law enforcement and emergency responders that are a part of the emergency call plan at a minimum of 48 hours before the demonstration.

END OF SECTION 28 26 26

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SECTION 28 31 00
FIRE ALARM AND DETECTION SYSTEM - ADM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 28 00 10 – Electronic Safety and Security General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

- A. Provide materials, equipment, labor and supervision necessary for a complete operational fire alarm system as required by the drawings and this section.
- B. This section is applicable to the Administration (ADM) building.
 - 1. New voice fire alarm system.

1.03 QUALITY ASSURANCE

- A. The system installation and wiring shall comply with applicable provisions of the current issue of NFPA 72, International Building Code, International Mechanical Code, Iowa State Building Code, Iowa Administrative Code, Americans with Disabilities Act, and codes and regulations of local authorities having jurisdiction.
- B. NEC Compliance: Comply with NEC as applicable to construction and installation of fire alarm and detection system components and accessories.
- C. UL Compliance and Labeling: Provide fire alarm and detection system components which are UL listed and labeled.

1.04 CODES AND STANDARDS

- A. All work shall be done in accordance with the applicable portion of the following codes and standards:
 - 1. National Fire Protection Association; NFPA 70, NFPA 72, NFPA 80, NFPA 20, NFPA 13
 - 2. National Electrical Manufacturers Association
 - 3. Standards of Institute of Electrical and Electronic Engineers
 - 4. International Building Code
 - 5. Occupational Safety and Health Act
 - 6. Iowa Administrative Code
 - 7. NECA Standards
 - 8. Americans With Disabilities Act (ADA)
 - 9. ASME A17.1 State Elevator Code
 - 10. Regulations of local authorities having jurisdiction.

1.05 SUBMITTALS

- A. Submittal data for the fire alarm equipment shall consist of shop drawings outlined in NFPA 72 shop drawing requirements and include but not limited to: block diagrams of layout and operation of the system, full size drawings with device locations and addresses, battery power calculations, audible and visual device power supply calculations, voltage drop calculations, list of device identification and addresses that will be displayed on the control panel(s), quantities of equipment, catalog cuts showing technical data necessary to evaluate the equipment and other descriptive data necessary to describe fully the equipment proposed.
- B. In no instance shall the contract drawings be reproduced for shop drawing submittals.
- C. Contractor is responsible for any fees associated with the review and approval of the fire alarm drawings and product data by the Authority Having Jurisdiction (AHJ). Contractor is also responsible for completion of the required fire alarm system submittal form and submittal of the final fire alarm shop drawings to the AHJ.

1.06 RECORD DRAWING REQUIREMENTS

- A. Record drawings shall be provided prior to the time of scheduling of the final inspection. They shall include the location of the overcurrent protection that feeds any fire alarm related equipment and shall be clearly marked on the drawings. Include changes made during system testing and acceptance.
 - 1. The following should be included:
 - a. Alarm initiation devices with addresses.
 - b. Alarm signal devices with module locations/addresses and circuit numbers.
 - c. Door holders and smoke dampers with module location and addressed.
 - d. Air handling units with module and relay locations and addresses.
 - e. Junction pull boxes.
 - f. Layout of conduit with circuit identification.
 - g. 120 VAC power sources for control panels, door holders, and fire/smoke dampers.
 - h. Location of all end of line resistors.
 - i. Calculations for voltage drop on circuits, battery, and audio amplifier sizing.

1.07 SYSTEM OPERATION

- A. Control of System: By the Fire Alarm Control Panel.
- B. System Supervision: Automatically detect and report open circuits, shorts, and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.
- C. Priority of Signals: Automatic alarm response functions resulting from an alarm signal from one zone or device are not altered by subsequent alarm, supervisory, or trouble signals. An alarm signal is the highest priority. Supervisory and trouble signals have second- and third-level priority. Higher-priority signals take precedence over signals of lower priority, even when the lower-priority condition occurs first. Annunciate and display all alarm, supervisory, and trouble signals regardless of priority or order received.
- D. Noninterference: A signal on one zone shall not prevent the receipt of signals from other zones.
- E. System Reset: All zones are manually resettable from the Fire Alarm Control Panel after initiating devices are restored to normal. Equipment that has been by-passed in software shall not change state of condition during a "reset".
 - 1. Fire Alarm Control Panel shall be reprogrammed so that it can be reset only when a security level access level of 3 or greater is used.
- F. Transmission to Remote Alarm Receiving Station: Automatically route alarm, supervisory, and trouble signals to a remote alarm station by means of a digital alarm communicator transmitter and telephone lines.
- G. System Alarm Capability during Circuit Fault Conditions: System wiring and circuit arrangement prevent alarm capability reduction when a single ground or open circuit occurs in an initiating device circuit, signal line circuit, or notification-appliance circuit.
- H. Loss of primary power at the Fire Alarm Control Panel initiates a trouble signal at the Fire Alarm Control Panel and the annunciator. An emergency power light is illuminated at both locations when the system is operating on the secondary power supply.
- I. Basic Alarm Performance Requirements: Unless otherwise indicated, operation of a manual station, automatic alarm operation of a smoke or flame or heat detector, or operation of a sprinkler flow device initiates the following:
 - 1. Notification-appliance operation.
 - 2. Initiation of alarm system except for individual sleeping rooms.
 - 3. Identification at the Fire Alarm Control Panel and the remote annunciator of the device originating the alarm.
 - 4. Transmission of an alarm signal to the remote alarm receiving station.
 - 5. Release of fire and smoke doors held open.
 - 6. Release of fire and smoke doors hold open if a detector adjacent to the door is in alarm.
 - 7. Recall of elevators if the alarm is initiated by a detector located in an associated machine room, hoistway, or elevator lobby.

8. Shutdown of fans and other air-handling equipment serving the fire zone where alarm was initiated.
 9. Initiation of smoke control sequence(s).
 10. Closing of smoke dampers in air ducts of system serving the fire zone where alarm was initiated.
 11. Recording of the event in the system memory.
 12. Initiation of automatic mass notification messages from main panel, annunciator panel and telephone interface.
- J. Alarm Silencing, System Reset and Indication: Controlled by switches in the Fire Alarm Control Panel and the remote annunciator.
1. Silencing-switch operation halts alarm operation of notification appliances and activates an "alarm silence" light. Display of identity of the alarm zone or device is retained.
 2. Subsequent alarm signals from other devices or fire zones reactivate notification appliances until silencing switch is operated again.
 3. When alarm-initiating devices return to normal and system reset switch is operated, notification appliances operate again until alarm silence switch is reset.
- K. Operating a heat detector in the elevator shaft or elevator machine room shuts down elevator power by operating a shunt trip device in the circuit feeding the elevator.
1. A field-mounted relay actuated by the Fire Alarm Control Panel closes the shunt trip circuit and operates building notification appliances and annunciator.
- L. Operating a smoke detector in the elevator shaft, elevator machine room or elevator lobby initiates Phase I Emergency Recall Operation automatically recalling the elevator to the main level of egress or the alternate recall level if the main level elevator lobby smoke detector is in alarm.
- M. Operating the fireman's control key for the elevator shall initiate Phase II Operation and bypass all automatic controls.
- N. Smoke detection for zones or detectors with alarm verification initiates the following:
1. Audible and visible indication of an "alarm verification" signal at the Fire Alarm Control Panel.
 2. Activation of a listed and approved "alarm verification" sequence Fire Alarm Control Panel " and the detector
 3. General alarm if the alarm is verified.
 4. Cancellation of the Fire Alarm Control Panel indication and system reset if the alarm is not verified.
- O. Sprinkler flow switch operation initiates the following:
1. General alarm
 2. Dedicated system horn/strobe device located at the fire department connection. This device shall only operate on sprinkler flow.
- P. Sprinkler valve-tamper switch operation initiates the following:
1. A supervisory, audible, and visible "valve-tamper" signal indication at Fire Alarm Control Panel and the annunciator.
 2. Transmission of supervisory signal to remote alarm receiving station.
- Q. Low-air-pressure switch operation on a dry-pipe or preaction sprinkler system initiates the following:
1. A supervisory, audible, and visible "sprinkler trouble" signal indication at the Fire Alarm Control Panel and the annunciator.
 2. Transmission of trouble signal to remote central station.
- R. Remote Detector Sensitivity Adjustment: Manipulation of controls at the Fire Alarm Control Panel causes the selection of specific addressable smoke detectors for adjustment, display of their current status and sensitivity settings, and control of changes in those settings. Same controls can be used to program repetitive, scheduled, automated changes in sensitivity of specific detectors. Sensitivity adjustments and sensitivity-adjustment schedule changes are recorded in system memory and are printed out by the system printer.

- S. Removal of an alarm-initiating device or a notification appliance initiates the following:
 - 1. A "trouble" signal indication at the Fire Alarm Control Panel and the annunciator for the device or zone involved.
 - 2. Transmission of trouble signal to remote alarm receiving station.
- T. Fire Alarm Control Panel Alphanumeric Display: Plain-English-language descriptions of alarm, supervisory, and trouble events; and addresses and locations of alarm-initiating or supervisory devices originating the report. Display monitoring actions, system and component status, system commands, programming information, and data from the system's historical memory.
 - 1. The upper line of the display shall indicate the zone in alarm according to the zone schedule on drawings.
 - 2. The lower line of the display shall indicate the address of the device in alarm.
- U. LED Lights:
 - 1. Only fire alarm zone lights and "device type" lights shall annunciate with a red LED. Device type, address and exact location shall annunciate on the digital readout.
 - 2. Any by-pass, disable, or trouble condition shall annunciate with an amber LED, a trouble sounder and annunciate on the digital readout. A "trouble pending" control module shall be included.

1.08 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Contractor shall provide the following spare parts in quantities shown, with a minimum of 1/item:

<u>Quantity</u>	<u>Type of Device Present</u>
5%	Smoke detectors and heat detectors
5%	Smoke and heat detector bases
5%	Monitor Modules
5%	Control Modules
1%	Duct detectors with housing and sample tubes
1%	Voice/Horn/strobe Units wall and ceiling variants
1%	Voice/Horn units wall and ceiling variants
1%	Strobes wall and ceiling variants
1%	Manual Pull Stations
5 units	Keys and Tools for access to locked and tamperproofed components

1.09 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Special Warranty: A written warranty, signed by Contractor and manufacturer, agreeing to replace components that do not meet requirements or that fall within the specified warranty period.
 - 1. Warranty Period: One year from date of Final Acceptance. Full warranty applies throughout the warranty period.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide fire alarm and detection systems of one of the following:
 - 1. Johnson Controls/Simplex
 - 2. Honeywell/Notifier: Premier Distributor

3. The equipment supplier shall provide the services of a factory trained representative. They shall supervise the system installation and final connections to the equipment and provide testing to assure that the system is in proper operating condition.

2.02 FIRE ALARM AND DETECTION SYSTEMS

- A. General: Provide fire alarm and detection system products of types, sizes, and capacities indicated, which comply with manufacturer's standard design, materials, components; construct in accordance with published product information, and as required for complete installation. Provide fire alarm and detection systems for applications indicated, with the sequence of operations, components and function features indicated.
- B. Materials and Equipment:
 1. Wiring System Materials: Provide basic wiring materials which comply with 26 00 10 – Electrical General Provisions, 26 05 53 – Raceway and Boxes for Electrical Systems, and 26 05 19 - Low-Voltage Electrical Power Conductors and Cables; types to be selected by Installer.
 - a. Junction and Pull Boxes:
 - 1) Junction and pull boxes shall be clearly marked. This shall be done by painting the covers red, and properly labeling them.
 - 2) All junction and pull boxes located at or above 8'0" from the floor shall be a minimum size of 4 11/16".
 - 3) No box extensions shall be permitted on new work.
 - 4) All junction boxes shall be readily accessible.
 - 5) No splicing in device mounting boxes.
- C. Manufacturer's Equipment: Provide manufacturer's standard construction equipment for material noted below:
 1. Central Fire Alarm Control Panel.
 - a. Notifier [model AM 1010 with voice]
 - 1) All devices to be served from one (1) panel.
 - b. Cabinet: Front lockable steel enclosure with a 14 gauge door and 16 gauge cabinet body, minimum. Arrange interior components so operations required for testing or for normal maintenance of the system are performed from the front of the enclosure. If more than one unit is required to form a complete control panel, fabricate with matching modular unit enclosure to accommodate components and to allow ample gutter space for field wiring and interconnecting panels.
 - 1) Identify each enclosure with an engraved, red, laminated, phenolic-resin nameplate with lettering not less than 1 inch high. Identify individual components and modules within cabinets with permanent labels.
 - 2) Mounting: Surface.
 - 3) Keys: Common to all system components.
 - c. Storage:
 - 1) The system stores and logs alarm and trouble events. Each recorded event includes the time and date of the event's occurrence.
 - 2) The system has the capability of recalling alarms, detector verifications, trouble conditions, acknowledgments, and silencing and reset activities in chronological order for the purpose of recreating an event history.
 - 3) Memory: Battery protected random access memory.
 - 4) Alarm Log: 300 events. Trouble Log: 300 events.
 - 5) Available Reports:
 - a) Alarm, trouble and test conditions including the time and date of each occurrence.
 - b) Status of each device in the system including detector sensitivity and verification tally.
 - c) Detector trending.

- d. Alarm and Supervisory Systems: Separate and independent in the Fire Alarm Control Panel. Alarm-initiating zone boards consist of plug-in cards. Construction requiring removal of field wiring for module replacement is unacceptable.
 - 1) Initiating Device Capacity: Adequate for quantity of devices indicated on drawings plus 10 percent.
 - a) Quantity of Simultaneous Alarms: Unlimited.
 - 2) Maintenance Alert: Automatically warns of a contaminated detector prior to false alarm.
 - 3) One additional signal line circuit (SLC) for future.
- e. Control Modules: Include types and capacities required to perform all functions of fire alarm systems. Each circuit shall have 10 percent spare capacity.
- f. Indications: Local, visible, and audible signals announce alarm, supervisory, and trouble conditions. Each type of audible alarm has a different sound.
- g. Resetting Controls: Prevent the resetting of alarm, supervisory, or trouble signals while the alarm or trouble condition still exists.
- h. Alphanumeric Display and System Controls: Arranged for interface between human operator at the Fire Alarm Control Panel and addressable system components, including annunciation, supervision, and control. Bypass switches shall provide specific alphanumeric display on the LCD annunciator.
 - 1) Display: A minimum of 80 characters; alarm, supervisory, and component status messages; and indicate control commands to be entered into the system for control of smoke detector sensitivity and other parameters.
 - 2) Keypad: Arranged to permit entry and execution of programming, display, and control commands.
 - 3) Bypass Switches: Activation of a bypass switch allows system testing without operation of the bypassed circuit. A trouble condition is generated upon operation of a bypass switch. Provide bypass switches for the following:
 - a) Remote monitoring station notification.
 - b) Audio circuit.
 - c) Visual circuit.
 - d) Smoke dampers.
 - e) Pressurization fans.
 - f) Elevator recall.
 - g) Fire doors.
 - 4) Control Switches: Switches allow manual control or testing of the following:
 - a) Smoke removal system.
 - b) Stair pressurization system.
 - c) Alarm Test. Operation of switch simulates an alarm condition in the same manner as if a manual station was operated. Notification of the fire department or central monitoring station is bypassed.
- i. Programming:
 - 1) System Memory: Non-volatile, programmable.
 - 2) Loading or editing of special instructions and operating sequences allowed as required.
 - 3) Capable of on-site programming to accommodate and facilitate expansion, building parameter changes, or changes as required by local codes.
 - 4) Provisions for disabling and enabling all addressable devices, and all monitoring, signaling and control circuits individually for maintenance and testing purposes.
 - 5) Provisions for distinctly different evacuation tone for disaster warning purposes.
 - 6) Smoke sensor sensitivity:
 - a) Automatic sensitivity adjustment of each sensor based on time of day and day of week.
 - b) Multiple sensitivity settings per sensor.
 - c) Pre-alarm or two-stage function to provide an indication when a sensor reaches 50 percent of its alarm threshold.

- 7) Contractor shall provide a detailed device description label that includes Room Name, Room Number, and Location in Building for common room name (i.e. Mech Room by main storage).
- j. Voice Alarm: An emergency communication system, includes central voice alarm system components complete with microphones, preamplifiers, amplifiers, and tone generators. Features include the following:
 - 1) Two alarm channels permit simultaneous transmission of different announcements to different zones or floors automatically or by using the central control microphone. All announcements are made over dedicated, supervised communication lines.
 - 2) Signal: Slow whoop.
 - 3) Digitally factory-recorded voice messages:
 - a) Alarm messages:
 - i. Alarm floor.
 - ii. Floor above alarm floor and floor below alarm floor.
 - iii. All other floors.
 - iv. All clear.
 - v. Weather alert.
 - vi. 5 custom mass notification messages.
 - 4) Message Content: Wording as directed by the Owner.
 - 5) Alarm tone sounds for a maximum of 10 seconds followed by automatic pre-selected voice evacuation messages. At the end of each voice evacuation message, the alarm tone shall resume after an adjustable time delay. The alarm sequence shall continue until the alarm silence switch at the fire alarm control panel has been operated.
 - 6) Status annunciator indicates the status of each voice alarm speaker zone.
 - 7) Manual control switch and gain control for each speaker circuit:
 - a) Provide an "all speaker" talk switch.
 - b) Provide momentary contact switches to manually select the following individual speaker circuits:
 - i. Each building level or approved fire zone.
 - ii. Each elevator car.
 - iii. Each stairwell.
 - iv. When speaker circuits are active, green LED's shall annunciate the appropriate speaker circuit. Individual speaker control shall be possible with the loss of A/C power.
 - 8) LED to indicate microphone push-to-talk button has been pressed. When speaker circuits are active, green LED's shall annunciate the appropriate speaker circuit. Individual speaker control shall be possible with the loss of A/C power.
 - 9) Amplifiers:
 - a) Size: 100 watts, minimum.
 - b) Self-contained filtered 24V DC power supply.
 - c) Transformer and amplifier monitor circuits.
 - d) Output: 25VRMS.
 - e) Frequency Response: 120 Hz to 12,000 Hz.
 - f) Quantity: As required to operate all system speakers simultaneously with 10 percent spare capacity.
 - g) Back-up amplifier quantity; One.
 - h) Microphone:
 - i) Hand-held, push-to-talk.
 - j) Dynamic communication type.
 - k) Frequency Range: 200 Hz to 4,000 Hz.
 - l) Self-winding five-foot coiled cable.
 - m) Stored within control panel.

- k. Control Switches:
- | | <u>Access Level</u> |
|--|---------------------|
| City disconnect with digital readout
(for both alarms and troubles) | Level 3 |
| Audio bypass with digital readout | Level 3 |
| Visual circuit bypass with digital readout | Level 3 |
| Smoke damper bypass with digital readout | Level 1 |
| Elevator bypass | Level 1 |
| Fire door bypass | Level 1 |
| Activation of elevator smoke damper | Level 1 |
- l. Provide air handler shutdown by specific unit or by fire zone (i.e. floor). Switch cannot be activated unless one or more of the following conditions occur:
- 1) Fire Alarm Control Panel is in access level 3.
 - 2) Panel is in alarm condition.
- m. Fire alarm control panel power shall be supplied by dedicated circuit(s).
2. Manual Pull Stations
- a. Description: Fabricated of metal, and finished in red with molded, raised-letter operating instructions of contrasting color.
- 1) Double-action mechanism requires two actions, such as a push and a pull, to initiate an alarm.
 - 2) Station Reset: Key or wrench operated; double pole, double throw; switch rated for the voltage and current at which it operates.
 - 3) Integral Addressable Module: Arranged to communicate manual-station status (normal, alarm, or trouble) to the Fire Alarm Control Panel.
 - 4) When surface-mounting pull stations, fire alarm equipment provider shall provide back boxes to match pull stations.
3. Smoke Detectors
- a. General: Include the following features:
- 1) Operating Voltage: 24-V dc, nominal.
 - 2) Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - 3) Plug-in Arrangement: Detector and associated electronic components are mounted in a module that connects in a tamper-resistant manner to a fixed base with a twist-locking plug connection. Terminals in the fixed base accept building wiring.
 - 4) Sensitivity: Can be tested and adjusted in-place after installation.
 - 5) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the Fire Alarm Control Panel.
 - 6) Remote Controllability: Unless otherwise indicated, detectors are analog-addressable type, individually monitored at the Fire Alarm Control Panel for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the Fire Alarm Control Panel.
- b. Photoelectric Smoke Detectors: Include the following features:
- 1) Sensor: LED or infrared light source with matching silicon-cell receiver.
 - 2) Detector Sensitivity: Between 2.5 and 3.5 percent/foot smoke obscuration when tested according to UL 268A.
 - 3) Magnetically actuated test switch.
 - 4) Integral Thermal Detector: Fixed-temperature type with 135 deg F setting.
- c. Duct Smoke Detector: Photoelectric type.
- 1) Sampling Tube: Design and dimensions as recommended by the manufacturer for the specific duct size, air velocity, and installation conditions where applied.
 - 2) Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.
 - 3) Remote Test Switch: Mount near mechanical room door or suitable maintenance type space on stainless steel cover plate. Include floor plan with protective cover to indicate location of corresponding duct smoke detector.

4. Other Detectors
 - a. Heat Detector, Combination Type: Actuated by either a fixed temperature or rate of rise of temperature.
 - 1) Analog temperature measuring device with setpoint (rating) set by Fire Alarm Control Panel.
 - 2) Mounting: Plug-in base, interchangeable with smoke detector bases, where available.
 - 3) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the Fire Alarm Control Panel.
5. Notification Appliances
 - a. Description: Equip for mounting as indicated and have screw terminals for system connections.
 - 1) Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly.
 - b. Visible Alarm Devices: Xenon strobe lights listed under UL 1971 with clear or nominal white polycarbonate lens. Mount lens on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- high letters on the lens.
 - 1) Rated Light Output: Field selectable 15 through 110 candela minimum per UL 1971 for ADA use unless otherwise indicated on drawing or required to meet NFPA 72 criteria.
 - 2) Strobe Leads: Factory connected to screw terminals.
 - 3) Synchronized operation.
 - 4) Mounting:
 - a) Ceiling: Flush with white baffle.
 - b) Wall: Surface with red or white housing.
 - c) Include skirt for surface mounted devices which do not conceal a standard 4-inch junction box.
 - c. Voice/Tone Speakers:
 - 1) High-Range Units: Rated 2 to 15 W.
 - 2) Low-Range Units: Rated 1 to 2 W.
 - 3) Minimum sound pressure 86dB at 10' with 1 watt tap
 - 4) Size:
 - a) Ceiling-Mounted Speakers: 8 inches.
 - b) Wall-Mounted speakers: 4 inches.
 - 5) Mounting:
 - a) Ceiling: Flush with white baffle.
 - b) Wall: Surface with red or white housing.
 - c) Include skirt for surface mounted devices which do not conceal a standard 4-inch junction box.
 - 6) Matching Transformers: Tap range matched to the acoustical environment of the speaker location.
 - 7) Voltage: Dual-voltage, field selectable at 25 or 70.7 nominal Vrms.
 - 8) Listing: UL 1480 for Fire Protective Signaling Systems
 - d. Fire Suppression System Horn/Strobe
 - 1) Weather resistant 24VDC combination audible/visual device to be located above the fire department connection.
 - 2) Wall mounted.
 - 3) Minimum sound pressure 86dB at 10' with 1 watt tap
 - 4) Rated light output: 75 candela
6. Magnetic Door Holders
 - a. Description: Units equipped for wall or floor mounting as indicated and are complete with matching door plate.
 - 1) Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.
 - 2) Wall-Mounted Units: Surface mounted, unless otherwise indicated.
 - 3) Contact Plate: Adjustable.

- 4) Armature Plate: Door mounted, adjustable 95 deg. horizontal, 5 deg. vertical.
- 5) Rating: 24-Vdc.
- b. Material and Finish: Match door hardware.
- c. Existing Units: Where existing units are shown for reconnection, provide necessary relays to operate at 24V dc.
- d. Mount units high on door.
7. Remote Annunciator
 - a. Description: LCD (liquid crystal display) duplicate annunciator functions of the Fire Alarm Control Panel for alarm supervisory, and trouble indications. Also duplicate manual switching functions of the Fire Alarm Control Panel including, acknowledging, silencing, reset, and test. Lockable steel enclosure keyed to match.
 - 1) Mounting: Surface cabinet.
 - b. Display Type and Functional Performance: Alphanumeric display same as the Fire Alarm Control Panel. Controls with associated LEDs permit acknowledging, silencing, resetting, and testing functions for alarm, supervisory, and trouble signals identical to those in the Fire Alarm Control Panel.
 - c. Provide LCD back box where surface mounting is necessary.
 - d. Provide microphone to allow paging from remote location.
8. Signal Circuit Remote Power Supply
 - a. General: Filtered, regulated, power limited with trouble indication; with emergency power supply.
 - b. Cabinet Lockable steel, surface-mounted enclosure, keyed to match, Fire Alarm Control Panel.
9. Battery Power Supply
 - a. General: Components include valve-regulated, recombinant lead acid battery; charger; and an automatic transfer switch.
 - 1) Battery Nominal Life Expectancy: 4 years as a minimum.
 - b. Battery Capacity: Comply with NFPA 72 for supplying a minimum of 24 hours of operation in normal condition, followed by no less than 15 minutes in full alarm for a system operating without a backup generator.
 - c. Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Provide capacity for 150 percent of the connected system load while maintaining batteries at full charge. If batteries are fully discharged, the charger recharges them completely within four hours. Charger output is supervised as part of system power supply supervision.
 - d. Integral Automatic Transfer Switch: Transfers the load to the battery without loss of signals or status indications when normal power fails.
10. Addressable Interface Devices
 - a. Monitor Module: Microelectronic module listed for use in providing a multiplex system address for listed fire and sprinkler alarm-initiating devices with normally open contacts; allows individual monitoring of non-addressable points.
 - b. Control Module: Microelectronic module listed for use in providing a multiplex system address to relays for system control functions.
 - 1) Relay: 24 VDC coil with red LED when in the "alarm" state; contacts rated 10A, 115 VAC, minimum; suitable for control function required.
11. Digital Alarm Communicator Transmitter
 - a. Listed and labeled under UL 864 and NFPA 72.
 - b. Cellular/IP Communicator:
 - 1) The cellular communicator connects directly to the primary and secondary analog UL Listed Fire Alarm Control Panel telephone ports.
 - 2) The Communicator will communicate to GSM networks in the area including 2G, 3G and 4G, LTE. The multi-GSM platform technology automatically detects and chooses the best network in the area based on signal strength and immediately self-adjusts for operation.
 - 3) Supports both dynamic (DHCP) or Public and Private Static IP addressing.

- 4) Communicates over any type of customer-provided Ethernet 10/100 Base network connection (LAN or WAN), DSL modem or cable modem.
 - 5) Data transmits over standard contact-ID protocol is secured with the industry's advanced encryption standard (AES 256 bit).
 - 6) Dual path communications: Uses Internet or GSM as primary.
 - 7) Provide with programming tools as required.
 - 8) Diagnostic LEDs: Signal strength and status indications.
 - 9) IP and GSM tested every day.
 - 10) All circuits shall be power-limited, per UL864 requirements.
 - 11) Unit shall be powered from the FACP.
12. Fire Alarm Documentation Cabinet
- a. Provide fire alarm documentation cabinet in accordance with NFPA-72 Cabinet to be labeled "SYSTEM RECORD DOCUMENTS". Space Age Systems SRD ACE-11 or equal.

PART 3 - EXECUTION

3.01 GENERAL

- A. Contractor/Installer shall meet with Owner prior to performing any work on existing/new system(s). Meeting shall determine existing building system functions and approach Contractor/Installer will take to remove the existing system and determine Contractor's/Installer's plan to install new system which includes raceway runs, typical wiring practices, and device and equipment installation, also to provide Contractor/Installer with Owner's expectations.
- B. The locations and spacing of alarm initiating devices and strobes indicated on the drawings are approximate. The equipment supplier shall verify device requirements and spacing and shall add devices as required to satisfy governing authorities. It shall be the responsibility of the equipment supplier or their representative to determine the type of detector required by local authorities for each type of installation.
- C. Install the fire alarm system in accordance with approved manufacturer's wiring diagrams. Furnish all conduit, wiring, outlet boxes, junction boxes, cabinets, and similar devices necessary for a complete installation. Boxes shall be installed in accessible spaces without requiring the removal of light fixtures or any other equipment.
- D. Coordinate system programming with the authority having jurisdiction.
- E. Provide 120 volt power to annunciator panels and remote signal circuit power supplies.
- F. Circuit breakers shall be identified and locked in accordance with NFPA 72. Provide Space Age Electronics model ELOCK-FA circuit lockout kit. Apply labels furnished with kit.
- G. Coordinate the installation of equipment and devices that pertain to the work of other trades with the appropriate contractors.
- H. Provide switch and fuse stat's (type SOU) installed within the Fire Alarm Control Panel disconnect 120 VAC power and separately all battery power.
- I. Coordinate the installation of equipment and devices that pertain to the work of other trades with the appropriate contractors.
 1. Provide connections to 120V smoke dampers provided by the mechanical contractor. Install 120V indicator lights provided with the dampers and wire to position switches.
 - a. Provide dedicated 120 volt circuits for smoke dampers.
 2. Provide shut-down relays to initiate HVAC shut down. Locations indicated on the fire alarm drawings are diagrammatic. Coordinate relay installation and HVAC unit shut-down with temperature controls contractor.
 3. Provide monitoring of fire suppression system. Coordinate installation with the Fire Suppression System installer.
 - a. Activation of water flow shall initiate general alarm.

- b. Activation of water flow shall initiate the dedicated combination horn and visual device located above the fire department connection. This device shall not initiate under any alarm other than water flow.
- c. Activation of valve tamper switches shall initiate a supervisory alarm.
- d. Provide monitoring of fire pump in accordance with NFPA 20.
- 4. Provide monitoring and control of elevator in accordance with ASME A17.1, International Building Code and State Elevator Code. Coordinate installation with the elevator installer.
 - a. Provide primary and secondary recall signals.
 - b. Monitor shunt-trip control power.
 - c. Provide shunt-trip signal in accordance with ASME A17.1. Provide timed delay of shunt-trip signal to allow elevator to be recalled. Coordinate length of time delay with elevator vendor.

3.02 DEVICE INSTALLATION

- A. Provide devices as indicated on drawings and as required to perform specified functions.
- B. Initiating Devices:
 - 1. Smoke Detectors:
 - a. Cover all smoke detection devices immediately after installation to maintain cleanliness.
 - b. Install within five feet of each door held open by the fire alarm system.
 - c. Where adjacent to an air shaft, supply diffuser or return grille, install smoke detector 36 inches minimum from the edge of the diffuser or grille.
 - d. Provide a smoke detector within 10 feet of each remote power supply panel.
 - 2. Duct Detectors:
 - a. Provide duct type smoke detectors in the return ductwork as indicated.
 - b. Locate duct smoke detector within 5' of fire dampers where a detector is indicated to be installed in a duct with a smoke.
 - c. Provide a remote alarm LED indicator for each duct smoke detector which is not readily visible or which is located above a ceiling or on a roof. Mount in an easily accessible and readily visible location. Label with the name of the unit served by the detector. Indicate whether the detector is installed in the supply or return ductwork.
 - d. Provide a labeled test switch with LED indicator for each duct smoke detector. Install switch at a height between 48 inches and 72 inches above finished floor.
 - 3. Provide heat detectors in areas where smoke detectors would be subject to false alarm.
 - 4. Program address for each device as directed by Owner or stated elsewhere in specification.
 - 5. Program device output text by address and geographic location.
 - 6. Provide an addressable interface module for each non-addressable device.
 - 7. Provide an addressable interface module for each non-addressable initiating device.
- C. Signaling Devices:
 - 1. Where plans indicate a signaling device installed adjacent to a manual station, install the signaling device on the wall directly above the manual station.
 - 2. Provide a minimum of two weatherproof audible signaling devices of the same type as other signaling devices provided with the system. The audible signaling devices will be located by the fire department connection to each building. Owner will determine the exact locations. Mount the devices on the exterior of the building. Provide a separate circuit for exterior audible signaling devices.
 - 3. In sprinkled buildings, provide a 24VDC system audible/visual device above the fire department connection. Coordinate location with division 21. Provide manual bypass from the Fire Alarm Control Panel.
 - 4. Set taps for toilet room speakers at 1/4 watt where toilet room is under 1000 square feet.
 - 5. Signaling devices shall be completely deactivated by pressing "signal silence".
 - 6. Audibles shall be placed so that they can be heard a minimum of 15 decibels above the ambient decibel level in all locations (refer to NFPA 72G and ISBC 17.705(12)).

- D. Control Devices:
 - 1. All devices controlled by the Fire Alarm Control Panel (i.e. dampers, doors, elevators, etc.) shall be operated by the use of "control modules" and not by relay type device on detector bases. No auxiliary equipment shall be directly connected to LMX control modules. Control modules shall activate a 24VDC relay with LED when in the "alarm".
 - 2. Elevators: Verify recall requirements with local codes, authorities, and installers prior to system programming. Provide control modules and relays as required.
 - 3. Provide a control module and relay for each door or group of doors to be held open.
 - 4. Provide control modules and relays as required to implement the required control sequences.
 - 5. Provide control modules and relays for remote indication of alarm and trouble conditions.
 - 6. Provide monitor module(s) where conventional non-addressable heat detectors and similar devices are installed.
- E. Door Holders:
 - 1. Mount at the top of each door to be held open unless otherwise indicated.
 - 2. Mount the magnet on the wall and the contact plate on the door. Provide extensions as necessary to assure proper mating between the magnet and contact plate. Magnet is to maintain hold of door under normal conditions.
 - 3. Adjust so the door is held parallel to the wall on which the magnet is mounted.
 - 4. Electromagnetic door holders which are indicated to be integral with a door closer shall be furnished by the Design Professional. Provide wiring so the door holders are normally energized from the fire alarm power supply.
- F. Cabinets:
 - 1. Mount Fire Alarm Control Panel and remote cabinets a maximum of 72 inches above finished floor to the top of the cabinet. Provide a 4-inch space between adjacent cabinets.

3.03 WIRING INSTALLATION

- A. Wiring Method: Use Class B wiring for communication between fire alarm panel equipment and Class B for field mounted devices. Install wiring in metal raceway according to Division 26, Section 26 0533 - Raceways and Boxes for Electrical Systems. Conceal raceway except in unfinished spaces and as indicated. Surface-mounted Wiremold shall be size 700 minimum.
- B. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by the manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors. Do not install spare conductors in conduits or junction boxes.
- C. Cable Taps: All cables in the fire alarm control panel, junction boxes, and pull boxes shall be clearly marked in English (i.e., SLC 1, 3rd Floor Speakers, etc.). Label all junction box covers to indicate circuits and/or devices enclosed. Label inside cover of all junction boxes in finished areas. Label outside cover of all junction boxes in unfinished/concealed areas.
- D. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red and provide circuit labels on inside of cover.
- E. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the Fire Alarm Control Panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.
- F. Install end-of-line resistors at the farthest device from panel or module in a separate junction box clearly marked "End-of-Line Resistor".

- G. Conductors (minimum size and color) and raceways shall be provided as listed below, unless otherwise recommended by the system manufacturer or required by the authority having jurisdiction:
- | | | | | | |
|----|----------------------------|---------|----------------|------------|-----------|
| 1. | 120VAC | 12AWG | | | |
| 2. | Initiating circuits | | #18 tw/sh pair | White (+) | Black (-) |
| 3. | Audible signaling circuits | | | | |
| | a. Horns/bells | | #14AWG | Red (+) | Black (-) |
| | b. Speakers | | #14 tw/sh pair | Red (+) | Black (-) |
| 4. | Module power | #14AWG | Violet (+) | Blue (-) | |
| 5. | Resettable module power | #14AWG | | Yellow (+) | Gray(-) |
| 6. | Visual signaling circuits | #14AWG | | Red (+) | Black (-) |
| 7. | Door holder/smoke dampers | #14AWG | | Brown (+) | White (-) |
| 8. | Control circuits | #14 AWG | | | |
- H. Conduit fill and box fill never to exceed 50%.
- I. No spare conductors shall be installed in conduits or junction boxes.
- J. 3M #130C rubber tape (or approved equal) shall be used to insulate grounding shields.
- K. If surface Wiremold is specified, it shall be no smaller than 700 size.
- L. All junction and pull boxes located at or above 8'-0" from the floor shall be a minimum size of 4-11/16" square by 2-1/8" deep.
- M. No box extensions shall be permitted on new work.
- N. All fire alarm devices, junction and pull boxes shall be installed so they are accessible without removing light fixtures, equipment, conduits, junction boxes or other items.
- O. No splicing will be allowed in device mounting boxes.
- P. "End of Line Resistors" shall be located at the device that is farthest away from the panel or module.
- Q. All devices being controlled by the fire alarm control panel (i.e. dampers, doors, etc.) shall be operated by the use of control modules and not by relay type devices in detector bases. No auxiliary equipment shall be directly connected to an addressable control module. Each control module shall activate a 24 vdc relay with LED when in the "alarm" state.
- R. Back boxes shall be provided by equipment supplier for any surface-mounted pull stations or signaling devices.
- S. T-taps may be used for signaling line circuits if manufacturer's recommendations are followed.

3.04 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals according to Division 26, Section Identification for Electrical Systems.
- B. Install instructions frame in a location visible from the Fire Alarm Control Panel.
- C. Circuit breakers shall be identified and locked in accordance with NFPA 72. Provide Space Age Electronics model ELOCK-FA circuit lockout kit. Apply labels furnished with kit. Affix the name and telephone number of the local service organization to the inside of the door of the Fire Alarm Control Panel and each remote cabinet.
- D. Label each control module to indicate the equipment controlled.
- E. Maintain wiring color codes throughout the system.
- F. All labels shall be on the inside of the cover.

3.05 GROUNDING

- A. Ground cable shields and equipment according to system manufacturer's written instructions to eliminate shock hazard and to minimize, to the greatest extent possible, ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

- B. Ground equipment and conductor and cable shields. For audio circuits, minimize, to the greatest extent possible, ground loops, common-mode returns, noise pickup, cross talk, and other impairments. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.

3.06 ACCEPTANCE TESTING

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and connections and to supervise pretesting, testing, and adjustment of the system. Report results in writing.
- B. Electrical Contractor shall be responsible for performing a "Pre-Test" of the Fire Alarm System and preparing/ completing "Test Log".
 - 1. All equipment shall be installed prior to completing "Pre-Test".
 - 2. Scope of the Pre-Test is to:
 - a. "Align, adjust, and balance the system."
 - b. Confirm compliance with the drawings and specifications.
 - c. Install, test and check for operation of 100% of all fire alarm equipment and items being controlled by the fire alarm system.
 - 3. Manufacturer's representative is to be involved in the pre-test.
 - 4. Perform a thorough cleaning of the fire alarm system so each detector's chamber value reads less than 50%.
 - 5. At completion of the pre-test, the fire alarm system is to be complete and ready for owner acceptance.
 - 6. Complete a "Test Log", a written record of inspections, tests, and detailed test results.
- C. In preparation for the final test, Contractor shall:
 - 1. Submit a "Test Log" and test forms from NFPA 72 and include a print out proving detector chamber values of less than 50% for all detectors.
 - 2. Provide a letter certifying pre-test compliance and a list of witnesses.
 - 3. Provide an up to date and complete printout of software at the time of final inspection and after any and all corrections or changes.
 - 4. Coordinate with Owner to record automatic messages for fire alarm conditions.
- D. Contractor shall perform a Final "Minimum System Test" per NFPA 72.
 - 1. Contractor shall test all equipment per minimum system testing requirements and maintain a "Test Log".
 - 2. Contractor to have sufficient personnel to conduct the test efficiently.
 - 3. Upon completion of the Final Test Contractor will submit the Test Log.
 - 4. Owner's representative has the authority to void the Final Test if it is proven during the Final Test that the Fire Alarm system installation is not complete.
 - a. Voiding the Final Test will require Contractor to schedule another Final Test.
 - 5. Upon approval of Final Test, successful owner training and submittal of completed "As-Built" drawings and O&M manuals, Owner will provide Contractor with acceptance of new Fire Alarm System.
 - a. Owner acceptance does not constitute "Project Closeout" or completion of "Final Punch List"
 - b. Owner acceptance only relieves Contractor of testing requirements, it does not relieve Contractor of other contract requirements.
 - c. Final Testing does not constitute Owner training.
 - d. Owner acceptance provides approval to activate the new Fire Alarm System as the primary system.
 - 6. Contractor shall perform final test in the presence of manufacturer's representative, Owner's representatives, and necessary local code authorities.

- E. Minimum System Tests' test the system according to procedures outlined in NFPA 72. Minimum required tests are as follows:
1. Verify the absence of unwanted voltages between circuit conductors and ground.
 2. Test all conductors for short circuits using an insulation-testing device.
 3. With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohm meter. Record the circuit resistance of each circuit on record drawings.
 4. Verify that the control unit is in the normal condition as detailed in the manufacturer's operation and maintenance manual.
 5. Test initiating and indicating circuits for proper signal transmission under open circuit conditions. One connection each should be opened at not less than 10 percent of initiating and indicating devices. Observe proper signal transmission according to class of wiring used.
 6. Test each initiating and indicating device for alarm operation and proper response at the control unit. Test smoke detectors with actual products of combustion.
 7. Test the system for all specified functions according to the approved operation and maintenance manual. Systematically initiate specified functional performance items at each station, including making all possible alarm and monitoring initiations and using all communications options. For each item, observe related performance at all devices required to be affected by the item under all system sequences. Observe indicating lights, displays, signal tones, and annunciator indications. Observe all voice audio for routing, clarity, quality, freedom from noise and distortion, and proper volume level.
 8. Test Both Primary and Secondary Power: Verify by test that the secondary power system is capable of operating the system for the period and in the manner specified.
 9. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets Specifications and complies with applicable standards.
 10. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Submit log on the satisfactory completion of test
- F. The manufacturer's authorized representative shall perform a 100% quality inspection of the final installation and in the presence of Contractor, Owner's Representative and local code and fire authorities, shall perform a complete finished test of all aspects of the system. A system certification verifying the proper system operation shall be required prior to acceptance.
- G. Audible sound level measurements shall be conducted throughout the entire building, and all spaces with the evacuation system off and sounding.

3.07 CLEANING AND ADJUSTING

- A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marred finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer. Provide detector cleaning report proving a maximum chamber value of 50% for all detectors.

3.08 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:
1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, adjusting, and maintaining equipment and schedules. Provide a minimum of 8 hours training.
 2. Provide a minimum of 8 hours of software program training.
 3. Training Aid: Use the approved final version of the operation and maintenance manual as a training aid.
 4. Schedule training with Owner, with at least seven days advance notice.

3.09 MAINTENANCE

- A. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels, controls, and sensitivities to suit actual occupied conditions. Provide up to three requested visits to Project site for this purpose.
- B. Provide a maintenance contract from the local service organization beginning on the date of Substantial Completion and remaining in force throughout the warranty period. Include required NFPA testing at times scheduled by Owner.
- C. Provide Owner with a proposal from the local service organization for a one-year maintenance contract beginning at the end of the warranty period.

END OF SECTION 28 31 00

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SECTION 28 31 02
FIRE ALARM AND DETECTION SYSTEM - HHS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 28 00 10 – Electronic Safety and Security General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

- A. Provide materials, equipment, labor and supervision necessary for a complete operational fire alarm system as required by the drawings and this section.
- B. This section is applicable to the Health and Human Services (HHS) building.
 - 1. Extension of the existing JCI/Simplex horn (non-voice) fire alarm system.

1.03 QUALITY ASSURANCE

- A. The system installation and wiring shall comply with applicable provisions of the current issue of NFPA 72, International Building Code, International Mechanical Code, Iowa State Building Code, Iowa Administrative Code, Americans with Disabilities Act, and codes and regulations of local authorities having jurisdiction.
- B. NEC Compliance: Comply with NEC as applicable to construction and installation of fire alarm and detection system components and accessories.
- C. UL Compliance and Labeling: Provide fire alarm and detection system components which are UL listed and labeled.

1.04 CODES AND STANDARDS

- A. All work shall be done in accordance with the applicable portion of the following codes and standards:
 - 1. National Fire Protection Association; NFPA 70, NFPA 72, NFPA 80, NFPA 20, NFPA 13
 - 2. National Electrical Manufacturers Association
 - 3. Standards of Institute of Electrical and Electronic Engineers
 - 4. International Building Code
 - 5. Occupational Safety and Health Act
 - 6. Iowa Administrative Code
 - 7. NECA Standards
 - 8. Americans With Disabilities Act (ADA)
 - 9. ASME A17.1 State Elevator Code
 - 10. Regulations of local authorities having jurisdiction.

1.05 SUBMITTALS

- A. Submittal data for the fire alarm equipment shall consist of shop drawings outlined in NFPA 72 shop drawing requirements and include but not limited to: block diagrams of layout and operation of the system, full size drawings with device locations and addresses, battery power calculations, audible and visual device power supply calculations, voltage drop calculations, list of device identification and addresses that will be displayed on the control panel(s), quantities of equipment, catalog cuts showing technical data necessary to evaluate the equipment and other descriptive data necessary to describe fully the equipment proposed.
- B. In no instance shall the contract drawings be reproduced for shop drawing submittals.
- C. Contractor is responsible for any fees associated with the review and approval of the fire alarm drawings and product data by the Authority Having Jurisdiction (AHJ). Contractor is also responsible for completion of the required fire alarm system submittal form and submittal of the final fire alarm shop drawings to the AHJ.

1.06 RECORD DRAWING REQUIREMENTS

- A. Record drawings shall be provided prior to the time of scheduling of the final inspection. They shall include the location of the overcurrent protection that feeds any fire alarm related equipment and shall be clearly marked on the drawings. Include changes made during system testing and acceptance.
 - 1. The following should be included:
 - a. Alarm initiation devices with addresses.
 - b. Alarm signal devices with module locations/addresses and circuit numbers.
 - c. Door holders and smoke dampers with module location and addressed.
 - d. Air handling units with module and relay locations and addresses.
 - e. Junction pull boxes.
 - f. Layout of conduit with circuit identification.
 - g. 120 VAC power sources for control panels, door holders, and fire/smoke dampers.
 - h. Location of all end of line resistors.
 - i. Calculations for voltage drop on circuits, battery, and audio amplifier sizing.

1.07 SYSTEM OPERATION

- A. Control of System: By the Fire Alarm Control Panel.
- B. System Supervision: Automatically detect and report open circuits, shorts, and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.
- C. Priority of Signals: Automatic alarm response functions resulting from an alarm signal from one zone or device are not altered by subsequent alarm, supervisory, or trouble signals. An alarm signal is the highest priority. Supervisory and trouble signals have second- and third-level priority. Higher-priority signals take precedence over signals of lower priority, even when the lower-priority condition occurs first. Annunciate and display all alarm, supervisory, and trouble signals regardless of priority or order received.
- D. Noninterference: A signal on one zone shall not prevent the receipt of signals from other zones.
- E. System Reset: All zones are manually resettable from the Fire Alarm Control Panel after initiating devices are restored to normal. Equipment that has been by-passed in software shall not change state of condition during a "reset".
 - 1. Fire Alarm Control Panel shall be reprogrammed so that it can be reset only when a security level access level of 3 or greater is used.
- F. Transmission to Remote Alarm Receiving Station: Automatically route alarm, supervisory, and trouble signals to a remote alarm station by means of a digital alarm communicator transmitter and telephone lines.
- G. System Alarm Capability during Circuit Fault Conditions: System wiring and circuit arrangement prevent alarm capability reduction when a single ground or open circuit occurs in an initiating device circuit, signal line circuit, or notification-appliance circuit.
- H. Loss of primary power at the Fire Alarm Control Panel initiates a trouble signal at the Fire Alarm Control Panel and the annunciator. An emergency power light is illuminated at both locations when the system is operating on the secondary power supply.
- I. Basic Alarm Performance Requirements: Unless otherwise indicated, operation of a manual station, automatic alarm operation of a smoke or flame or heat detector, or operation of a sprinkler flow device initiates the following:
 - 1. Notification-appliance operation.
 - 2. Initiation of alarm system except for individual sleeping rooms.
 - 3. Identification at the Fire Alarm Control Panel and the remote annunciator of the device originating the alarm.
 - 4. Transmission of an alarm signal to the remote alarm receiving station.
 - 5. Release of fire and smoke doors held open.
 - 6. Release of fire and smoke doors hold open if a detector adjacent to the door is in alarm.
 - 7. Recall of elevators if the alarm is initiated by a detector located in an associated machine room, hoistway, or elevator lobby.

8. Shutdown of fans and other air-handling equipment serving the fire zone where alarm was initiated.
9. Initiation of smoke control sequence(s).
10. Closing of smoke dampers in air ducts of system serving the fire zone where alarm was initiated.
11. Recording of the event in the system memory.
- J. Alarm Silencing, System Reset and Indication: Controlled by switches in the Fire Alarm Control Panel and the remote annunciator.
 1. Silencing-switch operation halts alarm operation of notification appliances and activates an "alarm silence" light. Display of identity of the alarm zone or device is retained.
 2. Subsequent alarm signals from other devices or fire zones reactivate notification appliances until silencing switch is operated again.
 3. When alarm-initiating devices return to normal and system reset switch is operated, notification appliances operate again until alarm silence switch is reset.
- K. Operating a heat detector in the elevator shaft or elevator machine room shuts down elevator power by operating a shunt trip device in the circuit feeding the elevator.
 1. A field-mounted relay actuated by the Fire Alarm Control Panel closes the shunt trip circuit and operates building notification appliances and annunciator.
- L. Operating a smoke detector in the elevator shaft, elevator machine room or elevator lobby initiates Phase I Emergency Recall Operation automatically recalling the elevator to the main level of egress or the alternate recall level if the main level elevator lobby smoke detector is in alarm.
- M. Operating the fireman's control key for the elevator shall initiate Phase II Operation and bypass all automatic controls.
- N. Smoke detection for zones or detectors with alarm verification initiates the following:
 1. Audible and visible indication of an "alarm verification" signal at the Fire Alarm Control Panel.
 2. Activation of a listed and approved "alarm verification" sequence Fire Alarm Control Panel " and the detector
 3. General alarm if the alarm is verified.
 4. Cancellation of the Fire Alarm Control Panel indication and system reset if the alarm is not verified.
- O. Sprinkler flow switch operation initiates the following:
 1. General alarm
 2. Dedicated system horn/strobe device located at the fire department connection. This device shall only operate on sprinkler flow.
- P. Sprinkler valve-tamper switch operation initiates the following:
 1. A supervisory, audible, and visible "valve-tamper" signal indication at Fire Alarm Control Panel and the annunciator.
 2. Transmission of supervisory signal to remote alarm receiving station.
- Q. Low-air-pressure switch operation on a dry-pipe or preaction sprinkler system initiates the following:
 1. A supervisory, audible, and visible "sprinkler trouble" signal indication at the Fire Alarm Control Panel and the annunciator.
 2. Transmission of trouble signal to remote central station.
- R. Remote Detector Sensitivity Adjustment: Manipulation of controls at the Fire Alarm Control Panel causes the selection of specific addressable smoke detectors for adjustment, display of their current status and sensitivity settings, and control of changes in those settings. Same controls can be used to program repetitive, scheduled, automated changes in sensitivity of specific detectors. Sensitivity adjustments and sensitivity-adjustment schedule changes are recorded in system memory and are printed out by the system printer.
- S. Removal of an alarm-initiating device or a notification appliance initiates the following:
 1. A "trouble" signal indication at the Fire Alarm Control Panel and the annunciator for the device or zone involved.

- 2. Transmission of trouble signal to remote alarm receiving station.
- T. Fire Alarm Control Panel Alphanumeric Display: Plain-English-language descriptions of alarm, supervisory, and trouble events; and addresses and locations of alarm-initiating or supervisory devices originating the report. Display monitoring actions, system and component status, system commands, programming information, and data from the system's historical memory.
 - 1. The upper line of the display shall indicate the zone in alarm according to the zone schedule on drawings.
 - 2. The lower line of the display shall indicate the address of the device in alarm.
- U. LED Lights:
 - 1. Only fire alarm zone lights and "device type" lights shall annunciate with a red LED. Device type, address and exact location shall annunciate on the digital readout.
 - 2. Any by-pass, disable, or trouble condition shall annunciate with an amber LED, a trouble sounder and annunciate on the digital readout. A "trouble pending" control module shall be included.

1.08 ACTIVE SYSTEMS

- A. Existing Fire Alarm Equipment: First and second levels of the building will be occupied throughout construction. Maintain operation of existing to remain fire alarm system. System downtime shall be kept to a minimum. Provide fire watch personnel as necessary for building occupant notification during downtime. Fire alarm system shall be left in full operational condition at the end of each workday.
- B. Equipment Removal:
 - 1. Package operational fire alarm and detection equipment that has been removed and deliver to Owner.
 - 2. Remove from site and legally dispose of existing material not designated for other disposition.

1.09 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Contractor shall provide the following spare parts in quantities shown, with a minimum of 1/item:

<u>Quantity</u>	<u>Type of Device Present</u>
5%	Smoke detectors and heat detectors
5%	Smoke and heat detector bases
5%	Monitor Modules
5%	Control Modules
1%	Duct detectors with housing and sample tubes
1%	Voice/Horn/strobe Units wall and ceiling variants
1%	Voice/Horn units wall and ceiling variants
1%	Strobes wall and ceiling variants
1%	Manual Pull Stations
5 units	Keys and Tools for access to locked and tamperproofed components

1.10 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Special Warranty: A written warranty, signed by Contractor and manufacturer, agreeing to replace components that do not meet requirements or that fall within the specified warranty period.
 - 1. Warranty Period: One year from date of Final Acceptance. Full warranty applies throughout the warranty period.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide fire alarm and detection systems of one of the following:
 - 1. Extension of existing Johnson Controls/Simplex
 - 2. The equipment supplier shall provide the services of a factory trained representative. They shall supervise the system installation and final connections to the equipment and provide testing to assure that the system is in proper operating condition.

2.02 FIRE ALARM AND DETECTION SYSTEMS

- A. General: Provide fire alarm and detection system products of types, sizes, and capacities indicated, which comply with manufacturer's standard design, materials, components; construct in accordance with published product information, and as required for complete installation. Provide fire alarm and detection systems for applications indicated, with the sequence of operations, components and function features indicated.
- B. Materials and Equipment:
 - 1. Wiring System Materials: Provide basic wiring materials which comply with 26 00 10 – Electrical General Provisions, 26 05 53 – Raceway and Boxes for Electrical Systems, and 26 05 19 - Low-Voltage Electrical Power Conductors and Cables; types to be selected by Installer.
 - a. Junction and Pull Boxes:
 - 1) Junction and pull boxes shall be clearly marked. This shall be done by painting the covers red, and properly labeling them.
 - 2) All junction and pull boxes located at or above 8'0" from the floor shall be a minimum size of 4 11/16".
 - 3) No box extensions shall be permitted on new work.
 - 4) All junction boxes shall be readily accessible.
 - 5) No splicing in device mounting boxes.
- C. Manufacturer's Equipment: Provide manufacturer's standard construction equipment for material noted below:
 - 1. Central Fire Alarm Control Panel.
 - a. Existing JCI/Simplex
 - 1) All devices to be served from one (1) panel.
 - b. Cabinet: Front lockable steel enclosure with a 14 gauge door and 16 gauge cabinet body, minimum. Arrange interior components so operations required for testing or for normal maintenance of the system are performed from the front of the enclosure. If more than one unit is required to form a complete control panel, fabricate with matching modular unit enclosure to accommodate components and to allow ample gutter space for field wiring and interconnecting panels.
 - 1) Identify each enclosure with an engraved, red, laminated, phenolic-resin nameplate with lettering not less than 1 inch high. Identify individual components and modules within cabinets with permanent labels.
 - 2) Mounting: Surface.
 - 3) Keys: Common to all system components.
 - c. Storage:
 - 1) The system stores and logs alarm and trouble events. Each recorded event includes the time and date of the event's occurrence.
 - 2) The system has the capability of recalling alarms, detector verifications, trouble conditions, acknowledgments, and silencing and reset activities in chronological order for the purpose of recreating an event history.
 - 3) Memory: Battery protected random access memory.
 - 4) Alarm Log: 300 events. Trouble Log: 300 events.

- 5) Available Reports:
 - a) Alarm, trouble and test conditions including the time and date of each occurrence.
 - b) Status of each device in the system including detector sensitivity and verification tally.
 - c) Detector trending.
- d. Alarm and Supervisory Systems: Separate and independent in the Fire Alarm Control Panel. Alarm-initiating zone boards consist of plug-in cards. Construction requiring removal of field wiring for module replacement is unacceptable.
 - 1) Initiating Device Capacity: Adequate for quantity of devices indicated on drawings plus 10 percent.
 - a) Quantity of Simultaneous Alarms: Unlimited.
 - 2) Maintenance Alert: Automatically warns of a contaminated detector prior to false alarm.
 - 3) One additional signal line circuit (SLC) for future.
- e. Control Modules: Include types and capacities required to perform all functions of fire alarm systems. Each circuit shall have 10 percent spare capacity.
- f. Indications: Local, visible, and audible signals announce alarm, supervisory, and trouble conditions. Each type of audible alarm has a different sound.
- g. Resetting Controls: Prevent the resetting of alarm, supervisory, or trouble signals while the alarm or trouble condition still exists.
- h. Alphanumeric Display and System Controls: Arranged for interface between human operator at the Fire Alarm Control Panel and addressable system components, including annunciation, supervision, and control. Bypass switches shall provide specific alphanumeric display on the LCD annunciator.
 - 1) Display: A minimum of 80 characters; alarm, supervisory, and component status messages; and indicate control commands to be entered into the system for control of smoke detector sensitivity and other parameters.
 - 2) Keypad: Arranged to permit entry and execution of programming, display, and control commands.
 - 3) Bypass Switches: Activation of a bypass switch allows system testing without operation of the bypassed circuit. A trouble condition is generated upon operation of a bypass switch. Provide bypass switches for the following:
 - a) Remote monitoring station notification.
 - b) Audio circuit.
 - c) Visual circuit.
 - d) Smoke dampers.
 - e) Pressurization fans.
 - f) Elevator recall.
 - g) Fire doors.
 - 4) Control Switches: Switches allow manual control or testing of the following:
 - a) Smoke removal system.
 - b) Stair pressurization system.
 - c) Alarm Test. Operation of switch simulates an alarm condition in the same manner as if a manual station was operated. Notification of the fire department or central monitoring station is bypassed.
- i. Programming:
 - 1) System Memory: Non-volatile, programmable.
 - 2) Loading or editing of special instructions and operating sequences allowed as required.
 - 3) Capable of on-site programming to accommodate and facilitate expansion, building parameter changes, or changes as required by local codes.
 - 4) Provisions for disabling and enabling all addressable devices, and all monitoring, signaling and control circuits individually for maintenance and testing purposes.
 - 5) Provisions for distinctly different evacuation tone for disaster warning purposes.

- 6) Smoke sensor sensitivity:
 - a) Automatic sensitivity adjustment of each sensor based on time of day and day of week.
 - b) Multiple sensitivity settings per sensor.
 - c) Pre-alarm or two-stage function to provide an indication when a sensor reaches 50 percent of its alarm threshold.
- 7) Contractor shall provide a detailed device description label that includes Room Name, Room Number, and Location in Building for common room name (i.e. Mech Room by main storage).
- j. Control Switches:

	<u>Access Level</u>
City disconnect with digital readout (for both alarms and troubles)	Level 3
Audio bypass with digital readout	Level 3
Visual circuit bypass with digital readout	Level 3
Smoke damper bypass with digital readout	Level 1
Elevator bypass	Level 1
Fire door bypass	Level 1
Activation of elevator smoke damper	Level 1
- k. Provide air handler shutdown by specific unit or by fire zone (i.e. floor). Switch cannot be activated unless one or more of the following conditions occur:
 - 1) Fire Alarm Control Panel is in access level 3.
 - 2) Panel is in alarm condition.
- l. Fire alarm control panel power shall be supplied by dedicated circuit(s).
- 2. Manual Pull Stations
 - a. Description: Fabricated of metal, and finished in red with molded, raised-letter operating instructions of contrasting color.
 - 1) Double-action mechanism requires two actions, such as a push and a pull, to initiate an alarm.
 - 2) Station Reset: Key or wrench operated; double pole, double throw; switch rated for the voltage and current at which it operates.
 - 3) Indoor Protective Shield: Factory-fabricated clear plastic enclosure, hinged at the
 - 4) Integral Addressable Module: Arranged to communicate manual-station status (normal, alarm, or trouble) to the Fire Alarm Control Panel.
 - 5) When surface-mounting pull stations, fire alarm equipment provider shall provide back boxes to match pull stations.
- 3. Smoke Detectors
 - a. General: Include the following features:
 - 1) Operating Voltage: 24-V dc, nominal.
 - 2) Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - 3) Plug-in Arrangement: Detector and associated electronic components are mounted in a module that connects in a tamper-resistant manner to a fixed base with a twist-locking plug connection. Terminals in the fixed base accept building wiring.
 - 4) Sensitivity: Can be tested and adjusted in-place after installation.
 - 5) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the Fire Alarm Control Panel.
 - 6) Remote Controllability: Unless otherwise indicated, detectors are analog-addressable type, individually monitored at the Fire Alarm Control Panel for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the Fire Alarm Control Panel.
 - b. Photoelectric Smoke Detectors: Include the following features:
 - 1) Sensor: LED or infrared light source with matching silicon-cell receiver.

- 2) Detector Sensitivity: Between 2.5 and 3.5 percent/foot smoke obscuration when tested according to UL 268A.
- 3) Magnetically actuated test switch.
- 4) Integral Thermal Detector: Fixed-temperature type with 135 deg F setting.
- c. Duct Smoke Detector: Photoelectric type.
 - 1) Sampling Tube: Design and dimensions as recommended by the manufacturer for the specific duct size, air velocity, and installation conditions where applied.
 - 2) Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.
 - 3) Remote Test Switch: Mount near mechanical room door or suitable maintenance type space on stainless steel cover plate. Include floor plan with protective cover to indicate location of corresponding duct smoke detector.
4. Other Detectors
 - a. Heat Detector, Combination Type: Actuated by either a fixed temperature or rate of rise of temperature.
 - 1) Analog temperature measuring device with setpoint (rating) set by Fire Alarm Control Panel.
 - 2) Mounting: Plug-in base, interchangeable with smoke detector bases, where available.
 - 3) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the Fire Alarm Control Panel.
5. Notification Appliances
 - a. Description: Equip for mounting as indicated and have screw terminals for system connections.
 - 1) Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly.
 - b. Visible Alarm Devices: Xenon strobe lights listed under UL 1971 with clear or nominal white polycarbonate lens. Mount lens on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- high letters on the lens.
 - 1) Rated Light Output: Field selectable 15 through 110 candela minimum per UL 1971 for ADA use unless otherwise indicated on drawing or required to meet NFPA 72 criteria.
 - 2) Strobe Leads: Factory connected to screw terminals.
 - 3) Synchronized operation.
 - 4) Mounting:
 - a) Ceiling: Flush with white baffle.
 - b) Wall: Surface with red or white housing.
 - c) Include skirt for surface mounted devices which do not conceal a standard 4-inch junction box.
 - c. Alarm Horns:
 - 1) Minimum sound pressure 87dB at 10'
 - 2) Separate in/out wiring for signal circuit
 - 3) Mounting:
 - a) Ceiling: Flush with white baffle.
 - b) Wall: Surface with red housing.
 - c) Include skirt for surface mounted devices which do not conceal a standard 4-inch junction box.
 - d. Fire Suppression System Horn/Strobe
 - 1) Weather resistant 24VDC combination audible/visual device to be located above the fire department connection.
 - 2) Wall mounted.
 - 3) Minimum sound pressure 86dB at 10' with 1 watt tap
 - 4) Rated light output: 75 candela

6. Magnetic Door Holders
 - a. Description: Units equipped for wall or floor mounting as indicated and are complete with matching door plate.
 - 1) Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.
 - 2) Wall-Mounted Units: Surface mounted, unless otherwise indicated.
 - 3) Contact Plate: Adjustable.
 - 4) Armature Plate: Door mounted, adjustable 95 deg. horizontal, 5 deg. vertical.
 - 5) Rating: 24-Vdc.
 - b. Material and Finish: Match door hardware.
 - c. Existing Units: Where existing units are shown for reconnection, provide necessary relays to operate at 24V dc.
 - d. Mount units high on door.
7. Remote Annunciator
 - a. Description: LCD (liquid crystal display) duplicate annunciator functions of the Fire Alarm Control Panel for alarm supervisory, and trouble indications. Also duplicate manual switching functions of the Fire Alarm Control Panel including, acknowledging, silencing, reset, and test. Lockable steel enclosure keyed to match.
 - 1) Mounting: Surface cabinet.
 - b. Display Type and Functional Performance: Alphanumeric display same as the Fire Alarm Control Panel. Controls with associated LEDs permit acknowledging, silencing, resetting, and testing functions for alarm, supervisory, and trouble signals identical to those in the Fire Alarm Control Panel.
 - c. Provide LCD back box where surface mounting is necessary.
8. Signal Circuit Remote Power Supply
 - a. General: Filtered, regulated, power limited with trouble indication; with emergency power supply.
 - b. Cabinet Lockable steel, surface-mounted enclosure, keyed to match, Fire Alarm Control Panel.
9. Battery Power Supply
 - a. General: Components include valve-regulated, recombinant lead acid battery; charger; and an automatic transfer switch.
 - 1) Battery Nominal Life Expectancy: 4 years as a minimum.
 - b. Battery Capacity: Comply with NFPA 72 for supplying a minimum of 24 hours of operation in normal condition, followed by no less than 15 minutes in full alarm for a system operating without a backup generator.
 - c. Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Provide capacity for 150 percent of the connected system load while maintaining batteries at full charge. If batteries are fully discharged, the charger recharges them completely within four hours. Charger output is supervised as part of system power supply supervision.
 - d. Integral Automatic Transfer Switch: Transfers the load to the battery without loss of signals or status indications when normal power fails.
10. Addressable Interface Devices
 - a. Monitor Module: Microelectronic module listed for use in providing a multiplex system address for listed fire and sprinkler alarm-initiating devices with normally open contacts; allows individual monitoring of non-addressable points.
 - b. Control Module: Microelectronic module listed for use in providing a multiplex system address to relays for system control functions.
 - 1) Relay: 24 VDC coil with red LED when in the "alarm" state; contacts rated 10A, 115 VAC, minimum; suitable for control function required.

11. Digital Alarm Communicator Transmitter (Existing)
 - a. Listed and labeled under UL 864 and NFPA 72.
 - b. Plain Old Telephone Service (POTS) Communicator:
 - 1) Unit receives an alarm, supervisory, or trouble signal from the Fire Alarm Control Panel panel, and automatically captures one or two telephone lines and dials a preset number for a remote central station. When contact is made with the central station(s), the signal is transmitted. The unit supervises up to two telephone lines. Where supervising two lines, if service on either line is interrupted for longer than 45 seconds, the unit initiates a local trouble signal and transmits a signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. When telephone service is restored, unit automatically reports that event to the central station. If service is lost on both telephone lines, the local trouble signal is initiated.

PART 3 - EXECUTION

3.01 GENERAL

- A. Contractor/Installer shall meet with Owner prior to performing any work on existing/new system(s). Meeting shall determine existing building system functions and approach Contractor/Installer will take to remove the existing system and determine Contractor's/Installer's plan to install new system which includes raceway runs, typical wiring practices, and device and equipment installation, also to provide Contractor/Installer with Owner's expectations.
- B. The locations and spacing of alarm initiating devices and strobes indicated on the drawings are approximate. The equipment supplier shall verify device requirements and spacing and shall add devices as required to satisfy governing authorities. It shall be the responsibility of the equipment supplier or their representative to determine the type of detector required by local authorities for each type of installation.
- C. Install the fire alarm system in accordance with approved manufacturer's wiring diagrams. Furnish all conduit, wiring, outlet boxes, junction boxes, cabinets, and similar devices necessary for a complete installation. Boxes shall be installed in accessible spaces without requiring the removal of light fixtures or any other equipment.
- D. Coordinate system programming with the authority having jurisdiction.
- E. Provide 120 volt power to annunciator panels and remote signal circuit power supplies.
- F. Circuit breakers shall be identified and locked in accordance with NFPA 72. Provide Space Age Electronics model ELOCK-FA circuit lockout kit. Apply labels furnished with kit.
- G. Coordinate the installation of equipment and devices that pertain to the work of other trades with the appropriate contractors.
- H. Provide switch and fuse stat's (type SOU) installed within the Fire Alarm Control Panel disconnect 120 VAC power and separately all battery power.
- I. Coordinate the installation of equipment and devices that pertain to the work of other trades with the appropriate contractors.
 1. Provide connections to 120V smoke dampers provided by the mechanical contractor. Install 120V indicator lights provided with the dampers and wire to position switches.
 - a. Provide dedicated 120 volt circuits for smoke dampers.
 2. Provide shut-down relays to initiate HVAC shut down. Locations indicated on the fire alarm drawings are diagrammatic. Coordinate relay installation and HVAC unit shut-down with temperature controls contractor.
 3. Provide monitoring of fire suppression system. Coordinate installation with the Fire Suppression System installer.
 - a. Activation of water flow shall initiate general alarm.
 - b. Activation of water flow shall initiate the dedicated combination horn and visual device located above the fire department connection. This device shall not initiate under any alarm other than water flow.

- c. Activation of valve tamper switches shall initiate a supervisory alarm.
- d. Provide monitoring of fire pump in accordance with NFPA 20.
- 4. Provide monitoring and control of elevator in accordance with ASME A17.1, International Building Code and State Elevator Code. Coordinate installation with the elevator installer.
 - a. Provide primary and secondary recall signals.
 - b. Monitor shunt-trip control power.
 - c. Provide shunt-trip signal in accordance with ASME A17.1. Provide timed delay of shunt-trip signal to allow elevator to be recalled. Coordinate length of time delay with elevator vendor.

3.02 DEVICE INSTALLATION

- A. Provide devices as indicated on drawings and as required to perform specified functions.
- B. Initiating Devices:
 - 1. Smoke Detectors:
 - a. Cover all smoke detection devices immediately after installation to maintain cleanliness.
 - b. Install within five feet of each door held open by the fire alarm system.
 - c. Where adjacent to an air shaft, supply diffuser or return grille, install smoke detector 36 inches minimum from the edge of the diffuser or grille.
 - d. Provide a smoke detector within 10 feet of each remote power supply panel.
 - 2. Duct Detectors:
 - a. Provide duct type smoke detectors in the return ductwork as indicated.
 - b. Locate duct smoke detector within 5' of fire dampers where a detector is indicated to be installed in a duct with a smoke.
 - c. Provide a remote alarm LED indicator for each duct smoke detector which is not readily visible or which is located above a ceiling or on a roof. Mount in an easily accessible and readily visible location. Label with the name of the unit served by the detector. Indicate whether the detector is installed in the supply or return ductwork.
 - d. Provide a labeled test switch with LED indicator for each duct smoke detector. Install switch at a height between 48 inches and 72 inches above finished floor.
 - 3. Provide heat detectors in areas where smoke detectors would be subject to false alarm.
 - 4. Program address for each device as directed by Owner or stated elsewhere in specification.
 - 5. Program device output text by address and geographic location.
 - 6. Provide an addressable interface module for each non-addressable device.
 - 7. Provide an addressable interface module for each non-addressable initiating device.
- C. Signaling Devices:
 - 1. Where plans indicate a signaling device installed adjacent to a manual station, install the signaling device on the wall directly above the manual station.
 - 2. Provide a minimum of two weatherproof audible signaling devices of the same type as other signaling devices provided with the system. The audible signaling devices will be located by the fire department connection to each building. Owner will determine the exact locations. Mount the devices on the exterior of the building. Provide a separate circuit for exterior audible signaling devices.
 - 3. In sprinkled buildings, provide a 24VDC system audible/visual device above the fire department connection. Coordinate location with division 21. Provide manual bypass from the Fire Alarm Control Panel.
 - 4. Set taps for toilet room speakers at 1/4 watt where toilet room is under 1000 square feet.
 - 5. Signaling devices shall be completely deactivated by pressing "signal silence".
 - 6. Audibles shall be placed so that they can be heard a minimum of 15 decibels above the ambient decibel level in all locations (refer to NFPA 72G and ISBC 17.705(12)).

- D. Control Devices:
 - 1. All devices controlled by the Fire Alarm Control Panel (i.e. dampers, doors, elevators, etc.) shall be operated by the use of "control modules" and not by relay type device on detector bases. No auxiliary equipment shall be directly connected to LMX control modules. Control modules shall activate a 24VDC relay with LED when in the "alarm".
 - 2. Elevators: Verify recall requirements with local codes, authorities, and installers prior to system programming. Provide control modules and relays as required.
 - 3. Provide a control module and relay for each door or group of doors to be held open.
 - 4. Provide control modules and relays as required to implement the required control sequences.
 - 5. Provide control modules and relays for remote indication of alarm and trouble conditions.
 - 6. Provide monitor module(s) where conventional non-addressable heat detectors and similar devices are installed.
- E. Door Holders:
 - 1. Mount at the top of each door to be held open unless otherwise indicated.
 - 2. Mount the magnet on the wall and the contact plate on the door. Provide extensions as necessary to assure proper mating between the magnet and contact plate. Magnet is to maintain hold of door under normal conditions.
 - 3. Adjust so the door is held parallel to the wall on which the magnet is mounted.
 - 4. Electromagnetic door holders which are indicated to be integral with a door closer shall be furnished by the Design Professional. Provide wiring so the door holders are normally energized from the fire alarm power supply.
- F. Cabinets:
 - 1. Mount Fire Alarm Control Panel and remote cabinets a maximum of 72 inches above finished floor to the top of the cabinet. Provide a 4-inch space between adjacent cabinets.

3.03 WIRING INSTALLATION

- A. Wiring Method: Use Class B wiring for communication between fire alarm panel equipment and Class B for field mounted devices. Install wiring in metal raceway according to Division 26, Section 26 05 33 - Raceways and Boxes for Electrical Systems. Conceal raceway except in unfinished spaces and as indicated. Surface-mounted Wiremold shall be size 700 minimum.
- B. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by the manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors. Do not install spare conductors in conduits or junction boxes.
- C. Cable Taps: All cables in the fire alarm control panel, junction boxes, and pull boxes shall be clearly marked in English (i.e. SLC 1, 3rd Floor Speakers, etc.). Label all junction box covers to indicate circuits and/or devices enclosed. Label inside cover of all junction boxes in finished areas. Label outside cover of all junction boxes in unfinished/concealed areas.
- D. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red and provide circuit labels on inside of cover.
- E. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the Fire Alarm Control Panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.
- F. Install end-of-line resistors at the farthest device from panel or module in a separate junction box clearly marked "End-of-Line Resistor".

- G. Conductors (minimum size and color) and raceways shall be provided as listed below, unless otherwise recommended by the system manufacturer or required by the authority having jurisdiction:
- | | | | | |
|----|----------------------------|-------------|----------------|--------------------------|
| 1. | 120VAC | 12AWG | | |
| 2. | Initiating circuits | | #18 tw/sh pair | White (+) Black (-) |
| 3. | Audible signaling circuits | | | |
| | a. | Horns/bells | #14AWG | Red (+) Black (-) |
| | b. | Speakers | #14 tw/sh pair | Red (+) Black (-) |
| 4. | Module power | #14AWG | Violet (+) | Blue (-) |
| 5. | Resettable module power | #14AWG | | Yellow (+) Gray(-) |
| 6. | Visual signaling circuits | #14AWG | | Red (+) Black (-) |
| 7. | Door holder/smoke dampers | #14AWG | | Brown (+) White (-) |
| 8. | Control circuits | #14 AWG | | |
- H. Conduit fill and box fill never to exceed 50%.
- I. No spare conductors shall be installed in conduits or junction boxes.
- J. 3M #130C rubber tape (or approved equal) shall be used to insulate grounding shields.
- K. If surface Wiremold is specified, it shall be no smaller than 700 size.
- L. All junction and pull boxes located at or above 8'-0" from the floor shall be a minimum size of 4-11/16" square by 2-1/8" deep.
- M. No box extensions shall be permitted on new work.
- N. All fire alarm devices, junction and pull boxes shall be installed so they are accessible without removing light fixtures, equipment, conduits, junction boxes or other items.
- O. No splicing will be allowed in device mounting boxes.
- P. "End of Line Resistors" shall be located at the device that is farthest away from the panel or module.
- Q. All devices being controlled by the fire alarm control panel (i.e. dampers, doors, etc.) shall be operated by the use of control modules and not by relay type devices in detector bases. No auxiliary equipment shall be directly connected to an addressable control module. Each control module shall activate a 24 vdc relay with LED when in the "alarm" state.
- R. Back boxes shall be provided by equipment supplier for any surface-mounted pull stations or signaling devices.
- S. T-taps may be used for signaling line circuits if manufacturer's recommendations are followed.

3.04 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals according to Division 26, Section Identification for Electrical Systems.
- B. Install instructions frame in a location visible from the Fire Alarm Control Panel.
- C. Circuit breakers shall be identified and locked in accordance with NFPA 72. Provide Space Age Electronics model ELOCK-FA circuit lockout kit. Apply labels furnished with kit. Affix the name and telephone number of the local service organization to the inside of the door of the Fire Alarm Control Panel and each remote cabinet.
- D. Label each control module to indicate the equipment controlled.
- E. Maintain wiring color codes throughout the system.
- F. All labels shall be on the inside of the cover.

3.05 GROUNDING

- A. Ground cable shields and equipment according to system manufacturer's written instructions to eliminate shock hazard and to minimize, to the greatest extent possible, ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

- B. Ground equipment and conductor and cable shields. For audio circuits, minimize, to the greatest extent possible, ground loops, common-mode returns, noise pickup, cross talk, and other impairments. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.

3.06 ACCEPTANCE TESTING

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and connections and to supervise pretesting, testing, and adjustment of the system. Report results in writing.
- B. Electrical Contractor shall be responsible for performing a "Pre-Test" of the Fire Alarm System and preparing/ completing "Test Log".
 - 1. All equipment shall be installed prior to completing "Pre-Test".
 - 2. Scope of the Pre-Test is to:
 - a. "Align, adjust, and balance the system."
 - b. Confirm compliance with the drawings and specifications.
 - c. Install, test and check for operation of 100% of all fire alarm equipment and items being controlled by the fire alarm system.
 - 3. Manufacturer's representative is to be involved in the pre-test.
 - 4. Perform a thorough cleaning of the fire alarm system so each detector's chamber value reads less than 50%.
 - 5. At completion of the pre-test, the fire alarm system is to be complete and ready for owner acceptance.
 - 6. Complete a "Test Log", a written record of inspections, tests, and detailed test results.
- C. In preparation for the final test, Contractor shall:
 - 1. Submit a "Test Log" and test forms from NFPA 72 and include a print out proving detector chamber values of less than 50% for all detectors.
 - 2. Provide a letter certifying pre-test compliance and a list of witnesses.
 - 3. Provide an up to date and complete printout of software at the time of final inspection and after any and all corrections or changes.
 - 4. Coordinate with Owner to record automatic messages for fire alarm and mass notification conditions.
- D. Contractor shall perform a Final "Minimum System Test" per NFPA 72.
 - 1. Contractor shall test all equipment per minimum system testing requirements and maintain a "Test Log".
 - 2. Contractor to have sufficient personnel to conduct the test efficiently.
 - 3. Upon completion of the Final Test Contractor will submit the Test Log.
 - 4. Owner's representative has the authority to void the Final Test if it is proven during the Final Test that the Fire Alarm system installation is not complete.
 - a. Voiding the Final Test will require Contractor to schedule another Final Test.
 - 5. Upon approval of Final Test, successful owner training and submittal of completed "As-Built" drawings and O&M manuals, Owner will provide Contractor with acceptance of new Fire Alarm System.
 - a. Owner acceptance does not constitute "Project Closeout" or completion of "Final Punch List"
 - b. Owner acceptance only relieves Contractor of testing requirements, it does not relieve Contractor of other contract requirements.
 - c. Final Testing does not constitute Owner training.
 - d. Owner acceptance provides approval to activate the new Fire Alarm System as the primary system.
 - 6. Contractor shall perform final test in the presence of manufacturer's representative, Owner's representatives, and necessary local code authorities.
- E. Minimum System Tests' test the system according to procedures outlined in NFPA 72. Minimum required tests are as follows:
 - 1. Verify the absence of unwanted voltages between circuit conductors and ground.

2. Test all conductors for short circuits using an insulation-testing device.
 3. With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohm meter. Record the circuit resistance of each circuit on record drawings.
 4. Verify that the control unit is in the normal condition as detailed in the manufacturer's operation and maintenance manual.
 5. Test initiating and indicating circuits for proper signal transmission under open circuit conditions. One connection each should be opened at not less than 10 percent of initiating and indicating devices. Observe proper signal transmission according to class of wiring used.
 6. Test each initiating and indicating device for alarm operation and proper response at the control unit. Test smoke detectors with actual products of combustion.
 7. Test the system for all specified functions according to the approved operation and maintenance manual. Systematically initiate specified functional performance items at each station, including making all possible alarm and monitoring initiations and using all communications options. For each item, observe related performance at all devices required to be affected by the item under all system sequences. Observe indicating lights, displays, signal tones, and annunciator indications. Observe all voice audio for routing, clarity, quality, freedom from noise and distortion, and proper volume level.
 8. Test Both Primary and Secondary Power: Verify by test that the secondary power system is capable of operating the system for the period and in the manner specified.
 9. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets Specifications and complies with applicable standards.
 10. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Submit log on the satisfactory completion of test
- F. The manufacturer's authorized representative shall perform a 100% quality inspection of the final installation and in the presence of Contractor, Owner's Representative and local code and fire authorities, shall perform a complete finished test of all aspects of the system. A system certification verifying the proper system operation shall be required prior to acceptance.
- G. Audible sound level measurements shall be conducted throughout the entire building, and all spaces with the evacuation system off and sounding.

3.07 CLEANING AND ADJUSTING

- A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marred finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer. Provide detector cleaning report proving a maximum chamber value of 50% for all detectors.

3.08 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:
1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, adjusting, and maintaining equipment and schedules. Provide a minimum of 8 hours training.
 2. Provide a minimum of 8 hours of software program training.
 3. Training Aid: Use the approved final version of the operation and maintenance manual as a training aid.
 4. Schedule training with Owner, with at least seven days advance notice.

3.09 MAINTENANCE

- A. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels, controls, and sensitivities to suit actual occupied conditions. Provide up to three requested visits to Project site for this purpose.

- B. Provide a maintenance contract from the local service organization beginning on the date of Substantial Completion and remaining in force throughout the warranty period. Include required NFPA testing at times scheduled by Owner.
- C. Provide Owner with a proposal from the local service organization for a one-year maintenance contract beginning at the end of the warranty period.

END OF SECTION 28 31 02

**SECTION 28 50 00
ACCESS CONTROL SYSTEM**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 28 00 10 – Electronic Safety and Security General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

- A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this access control in compliance with the specifications and drawings. Contractor will provide and install all of the required material to form a complete system.

1.03 CODES AND STANDARDS

- A. All work shall be done in accordance with the applicable portion of the following codes and standards:
 - 1. National Electrical Code
 - 2. Local Electrical Code
 - 3. National Fire Protection Association
 - 4. National Electrical Manufacturers Association
 - 5. Standards of Institute of Electrical and Electronic Engineers
 - 6. Applicable Building Codes
 - 7. Occupational Safety and Health Act
 - 8. Iowa Administrative Codes
 - 9. ANSI TIA-526-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
 - 10. ANSI TIA-526-14-C Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
 - 11. ANSI TIA-568-C.0 Generic Telecommunications Cabling For Customer Premises
 - 12. ANSI TIA-568-C.1 Commercial Building Telecommunications Cabling Standard Part 1: General Requirements
 - 13. ANSI TIA-568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standards
 - 14. ANSI TIA-568-C.3 Optical Fiber Cabling Components Standard
 - 15. ANSI TIA-568-C.4 Broadband Coaxial Cabling and Components Standard
 - 16. ANSI TIA-569-D Telecommunications Pathways and Spaces
 - 17. ANSI TIA-570-C Residential Telecommunications Infrastructure Standard
 - 18. ANSI TIA-598-D Optical Fiber Cable Color Coding
 - 19. ANSI TIA-606-B Administration Standard for Commercial Telecommunications Infrastructure
 - 20. ANSI TIA-607-B Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
 - 21. ANSI TIA-758-B Customer-owned Outside Plant Telecommunications Infrastructure Standard
 - 22. National Fire Protection Agency (NFPA - 70), National Electrical Code (NEC)

1.04 SUBMITTALS

- A. Submittal data for access control cabling and components shall consist of catalog cuts showing technical data necessary to evaluate the materials.

1.05 WORK BY OTHERS

- A. Unless noted otherwise, the building's Electrical Contractor will provide field device backboxes as needed, and conduit paths for use by Access Control Contractor. In general, the following is provided:
 - 1. Available space on Telecom Room plywood wall to surface mount head end equipment as required with telecommunications room ground bus bar available for grounding.

1.06 FIRESTOPPING

- A. Contractor shall be responsible for firestopping all conduit sleeves and cable tray where required to maintain integrity of fire and/or smoke walls. Contractor shall see architectural drawings for walls that require fire rating.

1.07 ACCEPTABLE ACCESS CONTROL CONTRACTORS

- A. The following contractors are pre-approved to bid this job:
 - 1. Access Control Contractor shall be a manufacturer authorized Dealer, verifiable by the manufacturer's representative. The Access Control Contractor shall also provide as a submittal documentation that they have been and continue to be an established manufacturer authorized dealer in good standing for a minimum of six continuous months before the project bid date. Bidding the project without certifications and attempting to acquire certifications after the bid is not acceptable.
 - 2. Contractor shall be located within 125 miles of the construction site to establish a potential two-hour response time for ongoing customer needs after construction completion.

PART 2 - PRODUCTS

2.01 ACCESS CONTROL CABLING AND COMPONENTS

- A. Acceptable Access Control System Manufacturers:
 - 1. Millennium Ultra
 - 2. Acceptable Access Control System Components:
 - a. Card Readers
 - 1) HID
 - 2) Approved equal
 - b. Access Control Cable
 - 1) CSC WESSCO
 - 2) Belden
 - c. Access Control Power Supply and Battery Backup
 - 1) Same as Access Control System
 - 2) Altronix
 - d. Access Control Door Controller
 - 1) Millennium
- B. Additional Access Control Requirements:
 - 1. The Access Control Contractor shall install and configure all local access control panels in the identified telecommunication rooms on the construction plans. Unless noted otherwise.
 - 2. The Access Control Contractor shall program all security system databases hardware configurations.
 - 3. The Access Control Contractor shall test and certify all access control communication and operation in accordance with the specifications and manufactures recommendations.
 - 4. The Access Control Contractor shall provide and install all cabling necessary for a complete and operational system taking into account all access control system devices called out on the plans (door contacts of all types, card readers, request to exit devices either internal to door hardware or surface mounted, and electrified door hardware of all types).
 - a. Access control cabling shall be home-run to the main system hardware, no splicing.

5. Any door identified on the plans that has any of the system components {door contacts (sometimes called position switches) of all types, card readers, request to exit devices, electrified door hardware of all types} shall be considered an access control system door.
6. Any door that is considered an access control system door shall have door contacts that can ensure the door is in the closed position and that the door is latched unless specifically noted otherwise. Both sides of a contact shall have a dedicated alarm point in the system.
7. If an electric strike is being provided with a latch bolt monitoring contact internal to the strike, a door slab contact shall still be provided to monitor the position of the slab. It shall be the Access Control Contractors responsibility to:
 - a. Verify that a suitable latch bolt monitoring contact is being specified in the door hardware or point out that what is specified is not compatible with the access control product being provided or the system requirements placed upon the Contractor.
 - b. Provide and install a door slab contact which, when these two are used together, accomplish the requirements of knowing that the door slab is physically closed, and the door hardware is engaged therefore ensuring a secured doorway.
8. The Access Control Contractor shall provide door controllers for all access control doors on the project that require a controller.
9. The Access Control Contractor shall provide and install all devices not specifically identified on the plans which are required for a complete and operational system for all access control system doors.
10. The Access Control Contractor shall provide and install one client software package on an Owner provided computer.
11. The Access Control Contractor shall provide training to all client operators and or managers identified by the client.
12. The Access Control Contractor shall furnish 250 proximity cards.
13. ADA door operation: Doors that are part of the access control system and have ADA electric openers shall be subject to the following hardware/software requirements.
 - a. The Access Control Contractor shall provide and install the necessary physical equipment and/or programming or other soft services necessary to meet these requirements.
 - b. The card reader shall be located in close proximity to the ADA button (whether on the building wall or on a bollard or equivalent).
 - c. During times when the system is scheduled to have the door of interest unlocked, pressing the ADA button (no card presentation required) shall physically open the door (and retract the latch as necessary). The access control system shall only unlock door trims during the unlocked door schedule (the latch shall remain engaged so the door cannot be opened by the wind or by people without using the door hardware). The Access Control Contractor shall coordinate with door hardware provided.
 - d. During times when the system is scheduled to have the door of interest locked, pressing the ADA button without a valid card presentation shall not activate any electric door hardware or electric opening devices.
 - e. During times when the system is scheduled to have the door of interest locked, pressing the ADA button after a valid card presentation shall activate any electric door hardware necessary to unlatch the door and activate the electric opening device(s).
 - 1) The valid card presentation shall only allow activation of these electrical systems for a limited amount of time after the card presentation.
 - 2) At no time shall a valid card presentation automatically activate the electric door opening device.
 - 3) Pressing the ADA button to have the door electrically open shall always be required, subject to the requirements listed above.

14. The Access Control head end (all cabinets if multiple) shall be furnished and installed with a minimum 7ah of battery backup serving no more than 8 doors each (i.e., if one panel serves 16 doors, then two 7ah batteries are required minimum). A battery backed power supply of the same manufacturer as the access control system shall be used if available, otherwise see this spec. 2.01 B.8 for an acceptable manufacturer to use.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install systems cables and auxiliary materials as indicated in accordance with access control manufacturer's written instructions, and recognized industry practices.
 1. Contractor shall use hook and loop type fasteners on all security cable. Tie wraps shall not be used.
- B. Identify all cables as to field location.
 1. Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type; either pre-numbered plastic-coated type or write-on type with clear plastic self-adhesive cover flap; numbered to show cable identification. Install within 6" of cable end.
- C. After completion, all cables shall be thoroughly tested.
 1. Contractor shall provide all instruments for testing the cables.
 2. Contractor shall demonstrate in the presence of Owner's representative that the access control is complete and operational.
 3. Contractor shall complete and submit the Certificate of System Demonstration.
- D. After completion, comprehensive As-Builts will be created and provided to Owner within 14 days.
 1. Two hard copies shall be provided to Owner detailing the entire access control after installation. Each field position shall be labeled and cross referenced to the appropriate head end position for ease of troubleshooting.

3.02 COMMISSIONING

- A. The Contractor shall coordinate a date/time with the Engineer after the system is fully operational, but before final payment, for the Contractor to provide a full system demonstration. This shall include all aspects of system operation that the user might encounter.

END OF SECTION 28 50 00

**SECTION 28 60 00
VIDEO SURVEILLANCE**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 28 00 10 – Electronic Safety and Security General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

- A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this surveillance system in compliance with the specifications and drawings. Contractor will provide and install all of the required material to form a complete system whether specifically addressed in the technical specifications or not.

1.03 SUBMITTALS

- A. Submittals for all Manufacturer and Contractor certifications (noted below) shall be submitted first.
- B. Submittal data for surveillance cabling and components shall consist of catalog cuts showing technical data necessary to evaluate the materials.

1.04 WORK BY OTHERS

- A. Unless noted otherwise, the building's Electrical Contractor will provide field device backboxes as needed, and conduit paths for use by surveillance Video Surveillance Contractor. In general, the following is provided:
 - 1. Grounded 19" data rack in Telecom Room by Telecom Contractor to mount head end equipment to.
 - 2. Available space on Telecom Room wall for power supply.

1.05 FIRESTOPPING

- A. Contractor shall be responsible for firestopping all conduit sleeves and cable tray where required to maintain integrity of fire and/or smoke walls. Contractor shall see architectural drawings for walls that require fire rating.

1.06 ACCEPTABLE VIDEO SURVEILLANCE CONTRACTORS

- A. The following contractors are pre-approved to bid this job:
 - 1. Video Surveillance Contractor shall be an Axis certified camera dealer in good standing for a minimum of six continuous months before the project bid date. This shall include factory trained and certified technicians in house for the installation of this project (six months experience applies here also). The dated Axis Silver certified camera dealer document and the dated technician training certificate are each required submittal items.
 - 2. The four or more submittal items (if multiple technicians) noted above are all criteria which determine if the Contractor is authorized to enter the team and begin work. No project work shall be authorized until these submittals are reviewed with a favorable response. Product data submittals are a separate submittal package and shall only be reviewed after the above items are resolved.

PART 2 - PRODUCTS

2.01 VIDEO SURVEILLANCE CABLING AND COMPONENTS

- A. Acceptable Manufacturers:
 - 1. Not Applicable
- B. Additional Video Surveillance Requirements:
 - 1. Cabling for IP cameras is by Division 27 11 00 contractor.
 - 2. IP cameras are by owner.

3. VMS is existing and owner controlled.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install surveillance systems cables and auxiliary materials as indicated in accordance with manufacturer's written instructions, and recognized industry practices.
 1. Contractor shall use hook and loop type fasteners on all security cable. Tie wraps shall not be used.
- B. Identify all cables as to field location.
 1. Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type; either pre-numbered plastic-coated type, or write-on type with clear plastic self-adhesive cover flap; numbered to show cable identification. Install within 6" of cable end.
- C. After completion, all cables shall be thoroughly tested.
 1. Contractor shall provide all instruments for testing the cables.
 2. Contractor shall demonstrate in the presence of Owner's representative that the surveillance system is complete and operational.
 3. Contractor shall complete and submit the Certificate of System Demonstration.
- D. After completion, comprehensive As-Builts will be created and provided to Owner within 14 days.
 1. Two hard copies shall be provided to Owner detailing the entire security system after installation. Each field position shall be labeled and cross referenced to the appropriate head end position for ease of troubleshooting.

3.02 COMMISSIONING

- A. The Contractor shall coordinate a date/time with the Engineer after the system is fully operational, but before final payment, for the Contractor to provide a full system demonstration. This shall include all aspects of system operation that the user might encounter.

END OF SECTION 28 60 00

SECTION 31 10 00 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Protecting existing vegetation to remain.
 - 2. Removing existing vegetation.
 - 3. Clearing and grubbing.
 - 4. Stripping and stockpiling topsoil.
 - 5. Stripping and stockpiling rock.
 - 6. Removing above- and below-grade site improvements.
 - 7. Disconnecting, capping or sealing, and removing site utilities or abandoning site utilities in place.
 - 8. Temporary erosion and sedimentation control.

1.3 DEFINITIONS

- A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.
- B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.
- C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects larger than 2 inches in diameter; and free of weeds, roots, toxic materials, or other nonsoil materials.
- D. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and indicated on Drawings.
- E. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and indicated on Drawings.
- F. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

- A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site. Note: All topsoil, stockpiled or otherwise are Owners property and shall remain onsite.

1.5 INFORMATIONAL SUBMITTALS

- A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.
 - 1. Use sufficiently detailed photographs or video recordings.
 - 2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plant designated to remain.
- B. Topsoil stripping and stockpiling program.

- C. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 QUALITY ASSURANCE

- A. Topsoil Stripping and Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.

1.7 FIELD CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed trafficways if required by Owner or authorities having jurisdiction.
- B. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
- C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- D. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.
- E. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 31 20 00 "Fill."
 - 1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged and that protection zones have been identified and enclosed.
- C. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.
- B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

- D. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

- A. Protect trees and plants remaining on-site.
- B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations.

3.4 EXISTING UTILITIES

- A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.
 - 1. Arrange with utility companies to shut off indicated utilities.
 - 2. Owner will arrange to shut off indicated utilities when requested by Contractor.
- B. Locate, identify, and disconnect utilities indicated to be abandoned in place.
- C. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Architect not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Architect's written permission.
- D. Excavate for and remove underground utilities indicated to be removed.

3.5 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
 - 1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
 - 2. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches below exposed subgrade.
 - 3. Use only hand methods or air spade for grubbing within protection zones.
 - 4. Chip removed tree branches and dispose of off-site.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
 - 1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.
 - 1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects larger than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.
- C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

3.7 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.
- B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
- B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials, and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION

31 22 00 – GRADING

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Rough grading the site for site structures and building pads.
- B. Replacement of topsoil and finish grading for planting.

1.02 RELATED REQUIREMENTS

- A. Section 31 10 00 - Site Clearing.
- B. Section 31 23 16 - Excavation.
- C. Section 31 23 23 - Fill: Filling and compaction.

1.03 PROJECT CONDITIONS

- A. Protect above- and below-grade utilities that remain.
- B. Protect plants, lawns, and other features to remain as a portion of final landscaping.
- C. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs from grading equipment and vehicular traffic.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Topsoil: Topsoil excavated on-site.
 - 1. Free of roots, rocks larger than 1/2-inch, subsoil, debris, large weeds and foreign matter.
- B. Other Fill Materials: See Section 31 23 23.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that survey bench mark and intended elevations for the Work are as indicated.

3.02 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Stake and flag locations of known utilities.
- B. Locate, identify, and protect from damage above- and below-grade utilities to remain.

3.03 ROUGH GRADING

- A. Remove subsoil from areas to be further excavated, re-landscaped, or re-graded.
- B. Do not remove wet subsoil, unless it is subsequently processed to obtain optimum moisture content.
- C. When excavating through roots, perform work by hand and cut roots with sharp axe.
- D. See Section 31 23 23 for filling procedures.
- E. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill.

3.04 SOIL REMOVAL and STOCKPILING

- A. Stockpile excavated topsoil on site.
- B. Stockpile subsoil to be re-used on site; remove remainder from site.
- C. Stockpiles: Use areas designated on site; pile depth not to exceed 8 feet; protect from erosion.

3.05 FINISH GRADING

- A. Before Finish Grading:
 - 1. Verify building and trench backfilling have been inspected.
 - 2. Verify subgrade has been contoured and compacted.
- B. Remove debris, roots, branches, stones, in excess of 1/2 inch in size. Remove soil contaminated with petroleum products.
- C. Where topsoil is to be placed, scarify surface to depth of 6 inches.
- D. In areas where vehicles or equipment have compacted soil, scarify surface to depth of 6 inches.
- E. Place topsoil in areas where seeding, sodding, and planting are indicated.
- F. Place topsoil where required to level finish grade.
- G. Except as specifically indicated otherwise, place topsoil to the following compacted thicknesses:
 - 1. Areas to be Seeded with Grass: 6 inches minimum. See Landscape Plans for details and compost requirements.
- H. Place topsoil during dry weather.
- I. Remove roots, weeds, rocks, and foreign material while spreading.
- J. Near plants spread topsoil manually to prevent damage.
- K. Fine grade topsoil to eliminate uneven areas and low spots. Maintain profiles and contour of subgrade.
- L. Lightly compact placed topsoil.

3.06 TOLERANCES

- A. Top Surface of Subgrade: Plus or minus 1/10 foot from required elevation.
- B. Top Surface of Finish Grade: Plus or minus 1/2 inch.

3.07 CLEANING

- A. Remove unused stockpiled topsoil and subsoil. Grade stockpile area to prevent standing water.
- B. Leave site clean and raked, ready to receive landscaping.

END OF SECTION

31 23 23 – FILL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Filling, backfilling, and compacting for footings, slabs-on-grade, paving, site structures, and utilities within the building.
- B. Backfilling and compacting for utilities outside the building to utility main connections.

1.02 RELATED REQUIREMENTS

- A. Section 31 22 00 - Grading: Removal and handling of soil to be re-used.
- B. Section 33 46 00 - Subdrainage: Filter aggregate and filter fabric for foundation drainage systems.
- C. Section 01 57 13 - Temporary Erosion and Sedimentation Control: Slope protection and erosion control.

1.03 PRICE & PAYMENT PROCEDURES

- A. See Section 01 20 00.

1.04 REFERENCE STANDARDS

- A. ASTM D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2007.
- B. ASTM D 2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2006.
- C. ASTM D2922 Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth); 2006.
- D. ASTM D3012 Standard Test Method for Thermal-Oxidative Stability of Polypropylene Using a Specimen Rotator Within an Oven; 2006.
- E. ASTM D 4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils; 2005.

1.05 DEFINITIONS

- A. Finish Grade Elevations: Indicated on drawings.
- B. Subgrade Elevations: Indicated on drawings.

1.06 SUBMITTALS

- A. Materials Sources: Submit name of imported materials source.
- B. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used.
- C. Compaction Density Test Reports.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Provide sufficient quantities of fill to meet project schedule and requirements. No area is available to store materials on site in advance of need.
- B. When fill materials need to be stored on site, locate stockpiles where indicated.
 - 1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
 - 2. Prevent contamination.
 - 3. Protect stockpiles from erosion and deterioration of materials.
- C. Verify that survey bench marks and intended elevations for the Work are as indicated.

PART 2 PRODUCTS

2.01 FILL MATERIALS

- A. General Fill: Subsoil excavated on-site and conforming to the following:
 - 1. Low-plasticity, cohesive type.
 - a. Liquid Limit: Less than 45 percent.
 - b. Plasticity Index: Less than 25 percent.
 - 2. Free of lumps larger than 3 inches, rocks larger than 2 inches, and debris.
 - 3. Conforming to ASTM D 2487 Group Symbol CL.
- B. Bedding Course: Class I Bedding Material, IDOT Standard Specification Section 4115, Gradation #3.
- C. Modified Subbase Fill: Dense angular crushed stone; IDOT Standard Specification Section 4123, gradation number 14 as indicated on drawings.
- D. Granular Drainage Fill: Angular crushed washed stone; open-graded, processed aggregate; free of shale, clay, friable material and debris; and conforming to the following:
 - 1. IOWA DOT Gradation 29, Section 4131.
- E. Sand: Natural river or bank sand; washed; free of silt, clay, loam, friable or soluble materials, and organic matter.
 - 1. Grade in accordance with ASTM D 2487 Group Symbol SW.
- F. Topsoil: See Section 31 22 00.

2.02 ACCESSORIES

- A. Filter Fabric: Polypropylene type, black non-biodegradable, non-woven, needle punched; "ADS-6600" manufactured by Advanced Drainage Systems, Inc. or approved equivalent.

2.03 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for general requirements for testing and analysis of soil material.
- B. Where fill materials are specified by reference to a specific standard, test and analyze samples for compliance before delivery to site.
- C. If tests indicate materials do not meet specified requirements, change material and retest.
- D. Provide materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Identify required lines, levels, contours, and datum locations.
- B. See Section 31 22 00 for additional requirements.
- C. See Section 00 31 00 for Geotechnical Report recommendations.
- D. Verify subdrainage, dampproofing, or waterproofing installation has been inspected.
- E. Verify structural ability of unsupported walls to support imposed loads by the fill.

3.02 PREPARATION

- A. Scarify and proof roll subgrade surface to a depth of 8 inches moisture condition and compact to the minimum specified percent compaction.
- B. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.
- C. Compact subgrade to density equal to or greater than requirements for subsequent fill material.

- D. Until ready to fill, maintain excavations and prevent loose soil from falling into excavation.

3.03 FILLING

- A. Fill up to subgrade elevations unless otherwise indicated.
- B. Employ a placement method that does not disturb or damage other work.
- C. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.
- D. Maintain optimum moisture content of fill materials to attain required compaction density.
- E. Granular / Aggregate Fill: Place and compact materials in equal continuous layers not exceeding 6 inches compacted depth.
- F. Soil Fill: Place and compact material in equal continuous layers not exceeding 8 inches compacted depth.
- G. Slope grade away from building minimum 2 inches in 10 ft, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.
- H. Correct areas that are over-excavated.
 - 1. Load-bearing foundation surfaces: See Structural Specifications.
 - 2. Other areas: Use general fill, flush to required elevation, compacted to minimum 98 percent of maximum dry density.
- I. Compaction Density Unless Otherwise Specified or Indicated:
 - 1. Under paving, slabs-on-grade, and similar construction: 95 percent of maximum dry density unless within one foot of final subgrade elevation, then 98 percent of maximum dry density.
 - 2. Under lawn areas: 90 percent of maximum dry density.
- J. Reshape and re-compact fills subjected to vehicular traffic.

3.04 FILL AT SPECIFIC LOCATIONS

- A. Use general fill unless otherwise specified or indicated.
- B. Subgrade Under Interior Slabs-On-Grade:
 - 1. Scarify and recompact top 12 inches of existing subsoil to 98 percent of its maximum dry density before placing additional fill.
 - 2. Use general fill at optimum moisture as replacement for unsatisfactory subsoil materials.
 - 3. Fill up to subgrade elevations below capillary barrier.
 - 4. Compact to 98 percent of maximum dry density.
- C. At Lawn Areas:
 - 1. Use general fill.
 - 2. Fill up to 6 inches below finish grade elevations.
 - 3. Compact to 90 percent of maximum dry density.
 - 4. See Section 31 22 00 for topsoil placement.
- D. Under paving:
 - 1. Scarify and recompact top 12 inches of existing subsoil to 98 percent of its maximum dry density before placing additional fill.
 - 2. Use additional general fill as required to achieve final subgrade elevation.
 - a. Maximum compacted depth of each lift: 8 inches.

- b. Compact to 95 percent of maximum dry density unless within one foot of final subgrade elevation, then 98 percent of maximum dry density.
- 3. See Section 32 11 23 for aggregate base course placed over fill.
- 4. Use sand leveling base under concrete sidewalks.
 - a. Compacted depth: 2 inches, minimum.
 - b. Compact to 95 percent of maximum dry density.

3.05 TOLERANCES

- A. Top Surface of General Filling: Plus or minus 1 inch from required elevations.
- B. Top Surface of Filling Under Paved Areas: Plus or minus 1 inch from required elevations.

3.06 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for general requirements for field inspection and testing.
- B. Owner will provide independent testing company at no cost to the contractor. Perform compaction density testing on compacted fill in accordance with ASTM D1556.
- C. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D 698 ("standard Proctor").
- D. If tests indicate work does not meet specified requirements, remove work, replace and retest.
- E. Frequency of Tests: Comply with recommendations of geotechnical engineer.
- F. Proof roll compacted fill at surfaces that will be under slabs-on-grade.
- G. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to OWNER.

3.07 CLEANING

- A. Remove unused materials; leave area in a clean and neat condition, properly prepared for subsequent grading operations.

END OF SECTION

31 23 33 - TRENCHING AND BACKFILLING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Trenching, backfilling and compacting for utilities outside the building.

1.02 RELATED SECTIONS

- A. Section 33 31 16 - Site Water Utility Distribution Piping.

1.03 REFERENCES

- A. ASTM D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft³).
- B. ASTM D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method; 2000.

1.04 DEFINITIONS

- A. Finish Grade Elevations: Indicated on drawings.
- B. Subgrade Elevations: Indicated on drawings.

1.05 SUBMITTALS

- A. See Section 01 33 00 - Construction Submittals, for submittal procedures.
- B. Materials Sources: Submit name of imported materials source.
- C. File Composition Test Reports: Results of laboratory tests on proposed and actual materials used.
- D. Compaction Density Test Reports.

1.06 PROJECT CONDITIONS

- A. Provide sufficient quantities of fill to meet project schedule and requirements. When necessary, store materials on site in advance of need.
- B. When fill materials need to be stored on site, locate stockpiles where designated.
 - 1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
 - 2. Prevent contamination.
 - 3. Protect stockpiles from erosion and deterioration of materials.
- C. Verify that survey bench marks and intended elevations for the Work are as indicated.
- D. Protect plants, lawns, and other features to remain.
- E. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

PART 2 PRODUCTS

2.01 FILL MATERIALS

- A. General Fill: Subsoil excavated on-site.
 - 1. Free of lumps larger than 3 inches, rocks larger than 2 inches, and debris.
- B. Bedding and Haunching Course: See Section 31 23 23
- C. Over Bedding and Haunching Course: Class 11 per SUDAS and Iowa City Figure 3010.201.
- D. Modified Subbase Fill: See Section 31 23 23.
- E. Granular Drainage Fill: See Section 31 22 00.

- F. Topsoil: See Section 31 22 00

2.02 ACCESSORIES

- A. Filter Fabric: As specified in Section 33 46 00 - Subdrainage.

2.03 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for general requirements for testing and analysis of soil material.
- B. If tests indicate materials do not meet specified requirements, change material and retest.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Identify required lines, levels, contours, and datum locations.
- B. Locate, identify, and protect utilities that remain and protect from damage.
- C. See Section 31 22 00 and 31 23 23 for additional requirements.

3.02 TRENCHING

- A. Notify Architect of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.
- B. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.
- C. Do not interfere with 45 degree bearing splay of foundations.
- D. Cut trenches wide enough to allow inspection of installed utilities.
- E. Hand trim excavations. Remove loose matter.
- F. Remove large stones and other hard matter which could damage piping or impede consistent backfilling or compaction.
- G. Remove excavated material that is unsuitable for re-use from site.
- H. Stockpile excavated material to be re-used in area designated on site in accordance with Section 31 22 00.
- I. Remove excess excavated material from site.

3.03 PREPARATION FOR UTILITY PLACEMENT

- A. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.
- B. Compact subgrade to density equal to or greater than requirements for subsequent fill material.
- C. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.

3.04 BACKFILLING

- A. Backfill to contours and elevations indicated using unfrozen materials.
- B. Fill up to subgrade elevations unless otherwise indicated.
- C. Employ a placement method that does not disturb or damage other work.
- D. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.
- E. Maintain optimum moisture content of fill materials to attain required compaction density.
- F. Granular Fill: Place and compact materials in equal continuous layers not exceeding 6 inches compacted depth.

- G. Soil Fill: Place and compact material in equal continuous layers not exceeding 8 inches compacted depth.
- H. Slope grade away from building minimum 2 inches in 10ft, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.
- I. Correct areas that are over-excavated.
 - 1. Thrust bearing surfaces: Use structural fill compacted to minimum 97 percent of maximum dry density.
 - 2. Other areas: Use general fill, flush to required elevation, compacted to minimum 97 percent of maximum dry density.
- J. Compaction Density Unless Otherwise Specified or Indicated:
 - 1. Under paving, slabs-on-grade, and similar construction: 98 percent of maximum dry density.
 - 2. At other locations: 95 percent of maximum dry density.
- K. Reshape and re-compact fills subjected to vehicular traffic.

3.05 BEDDING AND FILL AT SPECIFIC LOCATIONS

- A. Utility Piping for water, gas, electrical distribution, storm and sanitary piping:
 - 1. Bedding and Haunching Layers: Use Bedding Course.
 - 2. Cover with Class II material per Iowa City Figure 3010.201.
 - 3. Fill up to subgrade elevation.
 - 4. Compact in maximum 6-inch lifts to 98 percent of maximum dry density.

3.06 TOLERANCES

- A. Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.
- B. Top Surface of Backfilling Under Paved Areas: Plus or minus 1 inch from required elevations.

3.07 FIELD QUALITY CONTROL

- A. See Section 01 40 00 • Quality Requirements, for general requirements for field inspection and testing.
- B. Owner will provide independent testing company at no cost to contractor. Perform compaction density testing on compacted fill in accordance with ASTM 01556.
- C. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D 698 ("standard Proctor").
- D. Frequency of Tests: As recommended by geotechnical engineer.
- E. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.

3.08 CLEAN-UP

- A. Remove unused stockpiled materials; leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

END OF SECTION

32 11 23 - AGGREGATE BASE COURSES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Aggregate base course for vehicular pavement.

1.02 RELATED REQUIREMENTS

- A. Section 31 22 00 - Grading: Preparation of site for base course.
- B. Section 31 23 23 - Fill: Compacted fill under base course.
- C. Section 32 13 13 - Concrete Paving: Finish concrete surface course.

1.03 REFERENCE STANDARDS

- A. ASTM D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³; 2007.
- B. ASTM D 2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2006.
- C. ASTM D 4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils; 2005.
- D. IDOT Standard Specifications Section 4121, Gradation 12 (Granular Subbase).

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Materials Sources: Submit name of imported materials source.
- C. Aggregate Composition Test Reports: Results of laboratory tests on proposed and actual materials used.
- D. Compaction Density Test Reports.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. When necessary, store materials on site in advance of need.
- B. When aggregate materials need to be stored on site, locate stockpiles where indicated.
 - 1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
 - 2. Prevent contamination.
 - 3. Protect stockpiles from erosion and deterioration of materials.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Modified Subbase: IOWA DOT Gradation 14, Section 4123.
- B. Granular Drainage Fill: IOWA DOT Gradation 29, Section 4131.

2.02 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for general requirements for testing and analysis of aggregate materials.
- B. Test and analyze aggregate samples for compliance before delivery to site.
- C. If tests indicate materials do not meet specified requirements, change material and retest.
- D. Provide materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify substrate has been inspected, gradients and elevations are correct, and is dry.

3.02 PREPARATION

- A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.
- B. Do not place aggregate on soft, muddy, or frozen surfaces.
- C. Proof-roll with loaded tandem axle dump truck
- D. Areas where unsuitable conditions exist should be repaired by removing and replacing the unsuitable materials with properly compacted fill.

3.03 INSTALLATION

- A. Place aggregate base over compacted subgrade to a minimum compacted thickness of 6 inches.
- B. Compact to 98 percent of maximum dry density.
- C. Level and contour surfaces to elevations and gradients indicated.
- D. Add small quantities of fine aggregate to coarse aggregate as appropriate to assist compaction.
- E. Add water to assist compaction. If excess water is apparent, remove aggregate and aerate to reduce moisture content.
- F. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

3.04 TOLERANCES

- A. Flatness: Maximum variation of 1/4 inch measured with 10-foot straight edge.
- B. Scheduled Compacted Thickness: Within 1/4 inch.
- C. Variation From Design Elevation: Within 1/4 inch.

3.05 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for general requirements for field inspection and testing.
- B. Owner will provide independent testing company at no cost to contractor. Compaction density testing will be performed on compacted aggregate base course in accordance with ASTM D1556.
- C. Results will be evaluated in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D 698 ("standard Proctor").
- D. If tests indicate work does not meet specified requirements, remove work, replace and retest.
- E. Frequency of Tests: In accordance with requirements of Geotechnical Engineer, but no fewer than one for each 500 sf. An independent Geotechnical Consultant will be hired by Owner for compaction testing.

3.06 CLEANING

- A. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

END OF SECTION

32 13 13 - CONCRETE PAVING

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Portland Cement Concrete (PCC) Pavement
- B. Portland Cement Concrete (PCC) Curbs and Gutters

1.02 DESCRIPTION OF WORK

- A. Includes the requirements for the construction of full depth Portland Cement Concrete (PCC) pavement, and concrete curbs and gutters placed upon a prepared or corrected subgrade or previously constructed base or subbase. See Division 31 – Fill and Grading for subgrade and subbase construction specifications. This section shall also include final subgrade/subbase preparation for concrete paving.

1.03 SUBMITTALS

Follow the General Provisions (Requirements) and Covenants, as well as the following:

- A. PCC Mix Design: Mixes are Class C as defined in Iowa DOT Section 2301 and Materials I.M. 529. Unless otherwise specified in the contract documents, maturity method for strength determination prior to opening to traffic will be allowed.
 - 1. Two weeks prior to commencing any portland concrete placement, the Contractor shall submit a paving mix design for each different source of aggregate to be used for review and approval by the Engineer. Mixes or mix designs approved by the Iowa Department of Transportation or an independent testing laboratory shall be submitted.
- B. Mock-up: Integrally colored PCC pavement panel mock-up, 18"x18" with Type A Integral color and light sandblast finish.

1.04 SUBSTITUTIONS

Follow the General Provisions (Requirements) and Covenants.

1.05 SCHEDULING AND CONFLICTS

Follow the General Provisions (Requirements) and Covenants as well as the following:

Complete elements of the work that can affect line and grade in advance of other open cut construction unless noted on plans.

1.06 RESTRICTIONS ON OPERATIONS

The following shall apply unless specifically modified by the Engineer.

- A. Weather Conditions:
 - 1. Do not place concrete when stormy or inclement weather or temperature prevents good workmanship. Aggregates containing frozen lumps shall not be placed, and concrete shall not be placed on a frozen subgrade or subbase. The contractor will take all necessary actions to prevent the pavement from freezing.
 - a. Concrete placement may commence if the concrete mix temperature is a minimum of 40° and the air temperature is:
 - 1) After November 15, the air temperature is 36° and rising.
 - 2) After April 15, the air temperature is 32° and rising.
 - b. Concrete placement will stop when:
 - 1) After November 15, the air temperature is 37° and falling.
 - 2) After April 15, the air temperature is 32° and falling.
 - 3) With non-reinforced pavement, calcium chloride may be added to the mixing water to hasten initial set, if approved by Engineer.

- 4) Pavement damaged by inclement weather shall be removed and replaced.
- c. For warm weather, restrictions on concrete placement see SUDAS Section 7010, 1.07, D.
- B. Cold Weather Temperature Protection:
 - 1. All concrete pavement and curb/gutters, including exposed edges of the slab and curb, shall be cured. In addition, concrete less than 36 hours old shall be protected as follows:

Night Temperature Forecast	Type of Protection ¹
35°F to 32°F	One layer of burlap for concrete.
31°F to 25°F	Two layers of burlap or one layer of plastic on one layer of burlap.
Below 25°F	Four layers of burlap between layers of 4 mil (100 µm) plastic or equivalent commercial insulating material approved by the Engineer.

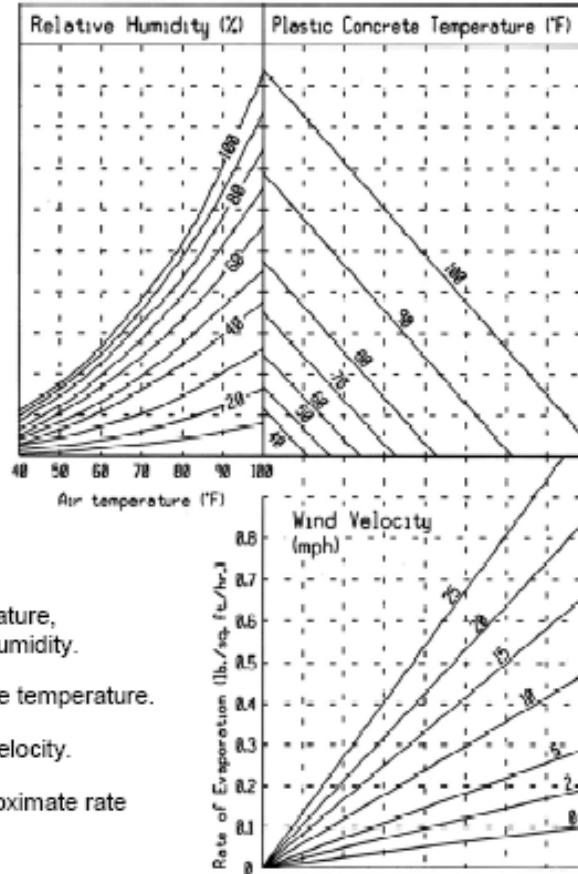
1 The protection shall remain until one of the following conditions is met:

- a. The pavement is 5 calendar days old.
- b. Opening strength is attained.
- c. Forecasted low temperatures exceed 35°F for the next 48 hours.
- d. Forecasted high temperatures exceed 55°F for the next 24 hours and subgrade temperatures are above 40°F.

- a. Paving operations shall be shut down in time to comply with protection requirements outlined above. In good weather, the header shall be placed at least 45 minutes before sunset. During cold weather, more time must be allowed for finishing and protection. All finishing and covering operations shall be performed prior to darkness. Temperature restrictions and protection requirements may be modified by the Engineer.
- b. Equivalent commercial insulating material approved by the Engineer may be used. This material shall be waterproof and have a minimum R value of 0.50. If initial set has not yet occurred, a layer of burlap shall be placed on top of concrete prior to placing insulating blankets.
- c. Vertical edges of pavement and back of curbs shall be cured by the same method used for curing the surface.
- c. Method of protection and materials used shall maintain the concrete above 40°F.
- C. Concrete Evaporation Protection:
 - 1. Hot weather condition is defined as any combination of the following conditions that tend to impair the quality of plastic concrete by accelerating the rate of moisture loss and rate of cement hydration causing thermal shrinkage and resulting in plastic shrinkage cracking or crazing.
 - High Ambient Temperature
 - High Concrete Temperature
 - Low Relative Humidity
 - High Wind Velocity
 - Solar Radiation
 - 2. Concrete evaporation protection will be based on the theoretical rate of surface evaporation when it exceeds 0.1 lbs. per square foot per hour. The National Weather Service's maximum air tem-

perature, relative humidity and maximum steady wind velocity without gusts, for the date and the location of the paving pour shall be used for the Theoretical Rate of Evaporation Chart.

Theoretical Rate of Evaporation Chart



To Use this Chart:

1. Enter with air temperature, move up to relative humidity.
2. Move right to concrete temperature.
3. Move down to wind velocity.
4. Move left, read approximate rate of evaporation

3. During hot weather conditions the Engineer may restrict concrete placement to early morning or evening hours.
4. Under hot weather conditions the Contractor will advise the Engineer of the results of the theoretical evaporation rate throughout paving operations.
5. The Contractor shall discontinue with placement of the concrete when the theoretical evaporation rate exceeds to 0.30 lbs./sq.ft./hr.
6. The protection practice by the Contractor will be as follows for the evaporation rate greater then 0.1 lbs./sq.ft./hr.
 - a. Immediately apply an approved evaporation retarder (Polymers) to the concrete pavement and curbs or increase the application cure to 1.5 times the standard specified rate.
 - b. Take special precautions to assure that the forms and subgrade are sufficiently moist or protected to avoid lowering the water content at the pavement/subgrade interface. In hot weather conditions the subgrade should also be moistened the evening before operations.
 - c. Assure that the time between placing and curing is minimized and eliminate delays.
 - d. Moisten concrete aggregates that are dry and absorptive.
 - e. Use a fog spray to raise the relative humidity of the ambient air if there is a delay in immediately applying the curing compound.

- f. Minimize solar heat by shading, wetting or covering concrete chutes or other equipment that comes in contact with plastic concrete.
- g. If shrinkage cracks should appear during finishing the cracks can be closed by striking each side of the crack with a float and refinishing.

D. Rain Protection:

- 1. The Contractor shall have available, near the site of the work, materials for proper protection of the edges and surface of concrete. Protective material may consist of sheets of burlap, or plastic film. Planks or other material with suitable stakes that can be used as temporary forms shall also be on hand; Iowa DOT Section 2301.
- 2. If initial set has not occurred, contractor shall take every precaution necessary to protect the surface texture of the concrete.
- 3. Failure to properly protect concrete shall constitute cause for removal and replacement of defective pavement, if so determined by the Engineer.

E. Safety Fence for Pavement:

- 1. At the end of each day's run and at all side streets, the Contractor shall erect and maintain such barriers and fencing as are necessary to protect the pavement from damage.

F. Repair of Pavement:

- 1. The Contractor shall protect the new pavement and its appurtenances from traffic, both public and that caused by its own employees and agents, at its expense. This includes the erection and maintenance of warning signs, lights, barricades, watchmen to direct traffic, and pavement bridges or crossovers.
- 2. Any part of the pavement damaged by traffic or other causes occurring prior to final acceptance of the pavement shall be repaired or replaced, at the discretion of the Engineer, at the Contractor's expense.
- 3. The Contractor shall not operate equipment with metal tracks, metal bucket blades, or metal motor patrol blades directly on new paving. The Contractor shall not unload soil or granular materials, including base rock for storage and future reloading directly onto new paving.

G. Utilities Protection: The Contractor will not start work until all utilities are located.

- 1. Repairs: When the Contractor disrupts or breaks known utilities of the Jurisdiction or privately owned utilities, such utilities shall be repaired at the Contractor's expense. Unnecessary delays in making repairs shall cause the Engineer to have such repairs made and the cost thereof deducted from the monies due the Contractor.
- 2. Drains, Pipe, Tiles: Existing subsurface drains, pipe, and tiles, which are disrupted or broken by reason of the construction shall be connected to the storm sewer, or another adequate outlet if storm sewer is not available. Should no outlet be readily available, the Engineer shall determine a suitable solution.
- 3. Water Stop Boxes and Services: The adjustment of stems and castings and/or repair of those broken or damaged by the Contractor shall be at the contractor's expense. Relocation of stop boxes and services shall be by bid items.

H. Use of Pavement: Time for opening pavement for use is determined by age or by test results from cylinder or beams taken during placement.

Minimum Age or Strength of Pavement Before Opening				
Class of Mix	Type of Cement	Minimum Age For Opening without Testing 4	Minimum Compressive Strength (psi)	Minimum Flexural Strength Center Point1 (psi)

A	Type I	14 Days 2	3,000	500
B	Type I	14 Days	2,400	400
C	Type I	7 Days	3,000	500
C	Type III	48 Hours	3,000	500
M	Type I	48 Hours	3,000	500
<p>1 Optional test method for primary roads 2 Ten days for concrete 8 inches or more in thickness 3 Five days for concrete 9 inches or more in thickness 4 Opening without testing only allowed upon approval of Engineer Note: Maturity Method may be allowed with approval of the Engineer; Iowa DOT Materials I.M. 383</p>				

PART 2 - PRODUCTS

2.01 TYPE OF PAVEMENT

Concrete pavement shall be one of two types, standard or slip form.

- A. Standard Concrete Pavement: Standard concrete pavement may be reinforced, or nonreinforced, as noted in the contract documents and shall consist of concrete of the class specified in the contract documents, reinforced as shown in the contract documents, placed within forms, and consolidated and finished by equipment operating on forms.
- B. Slip Form Pavement: Slip form pavement may be reinforced, or nonreinforced, and shall consist of concrete of the class specified in the contract documents, reinforced as shown in the contract documents, placed, consolidated, and finished without the use of fixed forms.

2.02 MATERIALS

- A. Portland Cement; Iowa DOT Section 4101 and Materials I.M. 401
 - 1. Type I; Normal Portland Cement:
 - a. Unless otherwise specified, cement shall meet Type I AASHTO M 85, Type I.
 - b. When the addition of fly ash to Type I cement is allowed in accordance with Iowa DOT Section 2301, or AASHTO M 240, Type I (PM) or Type IP, cement may be furnished and used within the same limitations.
 - c. The cement content of the concrete shall be that specified for Type I cement.
 - d. Use IDOT Class C-3 Mix
- B. Mineral Additives:
 - 1. Fly Ash Substitute:
 - a. Flyash per Iowa DOT Specifications for highway and Bridge Construction Section 4108 may be substituted for cement at the rates specified in section 2301.04E after notification and authorization by the owner's representative.
- C. Fine Aggregate for Concrete, Iowa DOT Section 4110: Clean, hard, durable mineral aggregate particles free from detrimental amount of silt, shale, coal, or organic matters.
 - 1. Natural sand as a result from disintegration of rock through erosional processes.
 - 2. From an approved source of not more than 2% shale and coal particles retained on a No. 16 sieve; not more than 2.5% silt by weight.
 - 3. Gradation: Iowa DOT Section 4109, gradation No. 1.

Sieve Size	Percent Passing
3/8 inch	100
No. 4	90 to 100
No. 8	70 to 100
No. 30	10 to 60
No. 200	0 to 1.5
Engineer may adjust gradation to allow for use of local aggregates.	

- D. Coarse Aggregate for Concrete, Iowa DOT Section 4115: Coarse aggregate shall consist of crushed stone particles.
1. Abrasion loss, in accordance with AASHTO T 96 shall not exceed 50.
 2. Freeze and thaw loss, in accordance with Iowa DOT Test Method 211, Method A, shall not exceed 6%.
 3. Objectionable Materials: The percentage of such materials shall not exceed the following percentages:

Objectionable Materials	Percent
Clay lumps	0.5
Coal and carbonaceous shale	0.5
Total of all shale, similar objectionable materials, and coal combined.	1.0
Sticks (wet weight) and other organic materials, except coal.	0.1
Unsound chert particles retained on 3/8" sieve (Non-structural concrete)	3.0
Unsound chert particles retained on the No. 4 sieve (Gradation No. 6) (1/2" nominal maximum size)	0.5
NOTE: Chert particles which break into three or more pieces when subjected to the freezing and thawing test will be considered unsound.	
Chert in aggregate produced from limestone sources is defined as unsound when any of the fractions of the crushed or uncrushed chert do not meet the soundness requirements.	

4. Durability: Soundness - Iowa DOT Test Method 408-A.
 - a. Class 2 durability stone shall be used unless stated otherwise in the contract documents or otherwise specified by the Engineer.
5. Gradation: Iowa DOT Section 4109, Gradation No. 3.

Sieve Size	Percent Passing
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1 1/2 inch	100
1 inch	95 to 100
1/2 inch	25 to 60
No. 4	0 to 10
No. 8	0 to 5
No. 200	0 to 1.5
Engineer may adjust gradation to allow for use of local aggregates.	

- E. Water Requirements: Iowa DOT Section 4102.
- F. Air Entrainment Admixture: Iowa DOT Section 4103, Materials I.M. 403, AASHTO M 154. Provisions shall be made to stir, agitate, or circulate air entraining admixtures prior to use so as to insure a uniform and homogeneous mixture.
- G. Admixtures: All liquid admixtures as listed below must meet the following requirements. Other admixtures may be used subject to the approval of the Engineer.
 - 1. Retarding and Water Reducing Admixtures: Iowa DOT Section 4103, Materials I.M. 403, AASHTO M 194.
 - 2. Accelerating admixtures (calcium chloride): Iowa DOT Section 2529.
- H. Reinforcing Steel:
 - 1. Deformed Bars: Billet steel bar, Iowa DOT Section 4151.
 - a. All deformed bars shall be epoxy coated, Iowa DOT Section 4151.
 - b. Tie bars shall be bent back reasonably straight. Tie bars broken during rebending shall be replaced by the Contractor at no cost by drilling a hole and setting the bar in epoxy. Tie bars shall meet the requirements of ASTM A 615 Grade 40 or 60.
 - c. All damage to epoxy coated bars shall be repaired by an approved patching material.
- I. Metal Keyways: Iowa DOT Section 4191
- J. Supports for Reinforcing Steel: Iowa DOT Section 2301.
- K. Joint Fillers and Sealers:
 - 1. Contraction Joint Sealers: Material for sealing sawed contraction and center line joints and other joints, as shown in the contract documents, shall meet the following requirements:
 - a. Poured Joint Sealer: Iowa DOT Section 4136.
 - 2. Preformed Expansion Joint Filler and Sealer: Preformed material for filling expansion joints shall be one of the following types. When the type is not specified, resilient filler shall be used.
 - a. Resilient Filler: Iowa DOT Section 4136, AASHTO M 213.
 - b. Polyethylene Joint Filler: Iowa DOT Section 4136, AASHTO T 42.
 - c. Elastomeric Joint Seals: Iowa DOT Section 4136, AASHTO M 220.
 - d. Preformed Urethane Foam Expansion Joint Filler: Iowa DOT Section 4136, Materials I.M. 436.
- L. Liquid Curing Compounds: Iowa DOT Section 4105, AASHTO M 148.
- M. Burlap Covering: Iowa DOT Section 4104.
 - 1. Jute and manilla fibers shall weigh not less than 10 ounces per square yard.

2. Shall be new material or reclaimed material which shall not have a deleterious effect upon fresh concrete.
- N. Color Admixture: Type A (for integrally colored concrete) – Dry pigment as manufactured by Solomon Colors. Color: 920 Onyx (1:2 Ratio.)

2.03 MIXES: IOWA DOT Materials I.M. 529

- A. Mix Design: Unless otherwise specified, the mix design shall be Class C mix with air entraining. Unless otherwise specified, the minimum compressive strength of the mix shall be 4,000 pounds per square inch at 28 days.
- B. Concrete Mixes: Shall meet the following design targets, as per Iowa DOT Section 2301 and Materials I.M. 529.

Basic Absolute Volumes of Materials for Unit Volume of Concrete							
Mix	W/C Basic	W/C Max.	Cement Min.	Water	Entrained Air	Fine Aggregate	Course Aggregate
A-4 ⁽¹⁾	0.474	0.532	0.108	0.161	0.060	0.335	0.336
B-4 ⁽²⁾	0.536	0.600	0.093	0.157	0.060	0.345	0.345
C-3WR	0.430	0.489	0.108	0.146	0.060	0.309	0.377
C-4	0.430	0.488	0.118	0.159	0.060	0.331	0.332
C-4WR	0.430	0.489	0.112	0.151	0.060	0.339	0.338
M-4	0.328	----	0.156	0.161	0.060	0.312	0.311
O-4WR	0.327	----	0.156	0.160	0.060	0.312	0.312
(1) Concrete Base, temporary pavement, or recreation trails only.							
(2) Temporary or recreation trails only.							
Other approved mixes will follow Iowa DOT Materials I.M. 529.							

Basic Absolute Volumes of Materials for Unit Volume of Concrete							
	W/C Basic	W/C Max.	Cement Min.	Water	Entrained Air	Class V.	Limestone
C-V47B	0.440	0.560	0.107	0.148	0.060	0.479	0.206
M-V	0.390	----	0.160	0.196	0.060	0.555	0.029

The above mixtures are based on Type I cements (Sp. G. = 3.14). Mixes using blended cements (Type IP, I(PM), IS, or I(SM)) must be adjusted for specific gravities listed in Iowa DOT Materials I.M. 401.

D. Consistency and Workability: The amount of materials used shall produce a concrete of uniform consistency, workability and a satisfactory surface finish.

Paving	Type of Concrete	Slump-in		% Air Content of Fresh Unconsolidated Concrete (Before Paver)			Target % Air, Consolidated Concrete (After Paver)
		Min.	Max.	Target or Initial*	Acceptable Range		
					Minus	Plus	
Machine Finish	A, B, C, C-V47B	1/2	2 1/2	7.5	1	1 1/2	6
Hand Finish	A, B, C, C-V47B	1/2	4	7	1	1 1/2	6
Curb & Gutter	C, C-V47B	----	3	7	1	1	6
Base (Machine Finish)	A	1/2	2 1/2	7	1	1 1/2	6
Base (Hand Finish)	A	1/2	4	7	1	1 1/2	6
Patches with CaCl	M, M-V	1	3	5**	2	2	N/A
Patch w/o CaCl	M, M-V	1	3	6 1/2	1 1/2	1 1/2	N/A

As per Iowa DOT Sections 2301, 2511, 2512, 2529, and 2530.

* The initial values for fresh concrete listed in the table above account for anticipated air loss during consolidation of concrete during placement and paving. Actual air loss and target value for air content of fresh concrete are established below.

** Prior to addition of Calcium Chloride

C. Use of Fly Ash: The Contractor shall notify the Engineer prior to making concrete mixture changes which have been approved. Mix proportions for the various mixes using fly ash are included in the Iowa DOT Materials I.M. 529. The following fly ash substitution rates shall replace those given in Iowa DOT Section 2301 and as referenced in Iowa DOT Materials I.M. 529:

Fly Ash Substitution Rates

Time Period	Cement Type	Fly Ash Substitution Rate by Weight
March 16 through September 14 ***	Type I and Type II	Not more than 20%
March 16 through September 14 ***	Type IP and Type I(PM)	Not more than 5% *
September 15 through October 15 September 15 through October 15	Type I and Type II Type IP and Type I(PM)	Not more than 15% None
October 16 thru March 15 October 16 thru March 15	Type I, Type II, & Type III Type IP and Type I(PM)**	None None
March 16 thru October 15	Type I, Type II, or Type III used in class M mixtures	Class C fly ash only at not more than 10%
* Note: If the cement manufacturer provides the Engineer with satisfactory concrete strength and freeze-thaw durability test results equivalent to concrete with the same Type IP or Type I(PM) cement without fly ash, the substitution rate may be increased to 10%. The testing and acceptance criteria shall be in accordance with Iowa DOT Materials I.M. 401.		
** Note: Proportions of Type IP and Type I(PM) shall be increased 15%, by weight, during this time period.		
*** Note: The March 16 through September 14 substitution rate may be used at any time the maturity method for monitoring concrete strength is utilized.		

Fly ash shall be transported, stored, hauled, and batched in such a manner to keep it dry.

2.04 MIXING EQUIPMENT

- A. Weighing and Proportioning Equipment: Iowa DOT Section 2001.
- B. Mixing Equipment: Iowa DOT Section 2001.
- C. Material Bins: Iowa DOT Section 2001.

2.05 CONCRETE BATCHING: IOWA DOT Section 2301

- A. Plant batching shall be Iowa DOT calibrated and approved. Provide copy of current calibrations and approvals.

2.06 CONCRETE MIXING

- A. Ready Mixed Concrete: Iowa DOT Section 2301.13
- B. All Methods: Each truck load shall be identified by a plant charge ticket showing plant name, contractor, project data, quantity, class, time batched, and water added at site.

2.07 CONCRETE PLACEMENT EQUIPMENT: IOWA DOT Section 2301.07

- A. Subgrade Finishing Equipment: Use mechanical excavating equipment designed for this purpose, approved by Engineer.
 - 1. Form line or path area for slip-form paving machine shall be constructed to final grade by form-line excavating equipment with automatic grade controls.
 - 2. Subgrade between forms or between path areas for slip-form machines constructed to final grade with automatically controlled subgrade excavating machine.
- B. Side Forms: Steel, minimum thickness: 5 gage, height at least equal to design thickness of pavement with base width at least 6 inches.
 - 1. Minimum section length: 10 feet, joint connections designed to permit horizontal and vertical adjustment with locking device to hold abutting sections firmly in alignment.
 - 2. Bracing, support, and staking must prevent deflection or movement of forms.
- C. Flexible Forms: Use steel or wood flexible forms for curves with radius less than 100 feet.
 - 1. Bracing, support, and staking must prevent deflection or movement of forms.
 - 2. Forms used to form back of curbs at returns shall have height at least equal to design thickness of pavement and curb height.
 - 3. Forms must be free from scale and surface irregularities; coat with release agent (see Section 7010, 3.03.G) prior to concrete placement.
- D. Consolidating and Finishing Equipment: Fixed form or slip form paving machines specifically designed for placing, striking off, consolidating, and finishing in single pass to required cross section.
 - 1. Consolidation of concrete by single pass of approved surface, tube, or internal vibrator operated in accordance with manufacturer's recommendations.
 - 2. Slip form equipment: Automatic horizontal and vertical controls required; equipment must spread concrete to uniform depth prior to finishing.
 - 3. Air screeds and vibrating screeds are approved consolidating and finishing equipment for cul-de-sacs, drives and some intersections. Small runs of pavement up to 250 feet maximum may also require screeds if paving machines are not practical.
 - 4. Equipment subject to approval of Engineer.
- E. Hand Finishing Equipment: Contractor shall provide tools including wood or magnesium floats, wood hand floats, point trowels, edgers, or other equipment necessary for proper finishing of concrete.
 - 1. Provide 2 light straightedges, 10 feet long, with handles not less than 12 feet long for use in detecting irregularities in surface; provide 2 heavy straightedges of similar size for use in correcting surface; provide 2 light straightedges 10 feet long for checking curb and gutter line.
 - 2. Provide approved vibrators for consolidating concrete.
 - 3. Provide metal or wood screed true to crown.
- F. Curing Equipment: Use pressure sprayer capable of applying a continuous uniform film of curing compound.
- G. Concrete Saws: Power operated concrete saws capable of cutting hardened concrete neatly.
- H. Joint Sealing Equipment: Equipment capable of heating and installing sealant in joints in accordance with manufacturer's recommendations.

PART 3 – EXECUTION

3.01 FINAL SUBGRADE/SUBBASE PREPARATION

- A. Natural Subgrade:

1. Subgrade construction shall be in accordance with Section 31 23 23.
 2. Subgrade Loading:
 - a. Where concrete trucks must travel on a prepared soil-type subgrade to unload and, as approved by the Engineer, watering of the subgrade must be limited to just ahead of the paving machine.
 - b. Repetitive loading on the subgrade by concrete trucks shall be minimized by entering and exiting the subgrade on side streets.
 - c. Loads in excess of the legal axle load shall not be allowed on the completed subgrade.
 - d. Partially loaded trucks may be required.
 - e. If subgrade/subbase failure occurs, the repair shall be coordinated with the Engineer.
 3. Maintenance of Subgrade:
 - a. The Contractor is responsible for maintenance of the completed subgrade during subsequent construction activities.
 - b. Before allowing hauling equipment to use the completed subgrade, the Contractor must be satisfied as to the effect this hauling equipment may have on the partially completed work.
- B. Granular Subbase:
1. Granular subbase for pavements shall be in accordance with Section 32 11 23
 2. Should the Contractor who constructed the subbase elect to overbuild the subbase, the paving contractor shall trim down to the design elevation and shape to the final template with an automatically controlled trimming machine.
 3. Excess material shall be salvaged and spread for use on any other approved project location or operation.
 4. The top 1 inch of the subbase shall be uniformly moist prior to paving.
 5. The paving operation shall be suspended where subbase stability has been lost.

3.02 SURFACE FIXTURE ADJUSTMENT

- A. Adjust manhole frames and other fixtures within area to be paved to conform to finished surface.
- B. Clean outside of fixture to depth of pavement before concrete placement.
- C. Box out fixtures for later adjustment where allowed. Size and shape of box out for intakes as shown in Standard Drawings.

3.03 FORMS SETTING

- A. Use form line excavating machine to establish subgrade of forms.
- B. Set base of forms at or below subgrade elevation with top of forms at pavement surface elevation.
- C. Extra height forms with Engineer approval may be used to back up integral curb and paving slab; set base at or below subgrade elevation with top of form at top of curb elevation.
- D. Secure forms in place to required grade and alignment.
- E. If voids occur under forms, remove forms and rework subgrade to proper elevation and density; reinstall forms.
- F. If the soil supporting the form is softened by rain or standing water so that form is inadequately supported, remove forms and rework subgrade to proper elevation and density; reinstall forms.
- G. Coat forms with release agent before concrete is placed.
- H. Place forms true to alignment and free of latent concrete.

3.04 REINFORCING PLACEMENT

- A. Reinforcing metal shall be clean, straight, free from distortion and rust, and shall be firmly secured in position as detailed.
- B. All reinforcing metal shall be placed in approved storage to prevent damage; do not distribute along the work site except as needed to avoid delay in paving.
- C. Place reinforcing steel as shown on the detailed drawings or as specified; support and secure bars by approved chair and wire assemblies; bars to be checked by the Engineer upon notification from the Contractor.
- D. Joint Steel:
 1. Tie bars for all longitudinal joints shall be installed so as to be in the intended position in the completed pavement. Tie bars for all longitudinal joints shall be positioned on chairs and secured against movement with metal stakes during placing and finishing of concrete unless otherwise approved by the Engineer. If approved by the Engineer, bars may be placed in position by a machine or other method. For tie steel that is placed mechanically in plastic concrete, the Engineer shall:
 - a. Manually check locations and depth of the steel in the plastic concrete behind the slip form paver using the following frequencies:
 - once every 200 lineal feet for tangent roadway sections
 - in at least three locations within all horizontal curve sections
 - for each inspection, at least two tie steel locations within a panel
 - b. Using a magnetic locator, verify locations of tie steel in hardened concrete every day. Check out-of-tolerance tie steel to identify the extent of the problem for a retrofit correction.
 2. The Contractor shall provide adequate means to ensure that the load transfer devices and tie bars for key type joints are properly secured to maintain correct position and alignment during the placement of concrete.
- E. Dowel Holes:
 1. Holes for both deformed and smooth dowel bars shall be drilled into the face of the existing slab at midpoint.
 2. Drills used to make holes shall be held in a rigid frame to assure proper horizontal alignment with misalignment not to exceed 1/4 inch in the vertical or horizontal plane.
 3. The equipment used shall be operated so as to prevent damage to the pavement being drilled. The drilling procedure shall be approved by the Engineer. The hole shall be blown clean to eliminate all dust.
 4. Dowels shall be epoxied into place in the existing slab. Epoxy bonding compound shall meet requirements of Section 7010, 2.02, P.

3.05 CONSTRUCTION OF JOINTS

- A. General:
 1. Longitudinal and transverse joints shall be constructed of the type, dimensions, and at the locations required, as described by these specifications, or as detailed by the plans or special provisions.
 2. Longitudinal joints shall be coincident with or parallel to the pavement center line unless shown otherwise on the plans.
 3. All transverse joints shall be at right angles to the center line and shall extend the full width of the pavement unless otherwise specified.
 4. All joint fillers shall be installed as shown in the contract documents.
- B. Expansion Joint:

1. Install expansion joints between new pavement construction and the faces of buildings, stoops, existing slabs, and other fixtures and as shown on Standard Drawings. Expansion joints shall be preformed foam expansion joint material. Joints at these locations shall be sealed with a self-leveling polyurethane.
- C. Saw Joints:
1. Joint locations shall be chalked with a string line before sawing.
 2. Joint dimensions:
 - a. All transverse contraction joints shall be sawed at a maximum spacing of 12 feet. All joints shall be sawed to a depth as shown on the drawings.
 3. In order to prevent shrinkage cracks, sawing shall be commenced promptly after the pavement has obtained sufficient strength to resist tearing of the concrete adjacent to the joint during the process of sawing.
 4. Longitudinal joints shall be sawn within 24 hours of the concrete being placed.
 5. If necessary, the sawing operations shall be carried on both day and night.
- D. Construction Joints:
1. Longitudinal or transverse construction joints shall be placed between adjacent lanes of concrete and at end-of-day header runs.
 2. Manhole boxouts shall be located and placed on grade prior to paving. Manhole boxouts are required for two piece castings for sanitary/storm manholes.
 3. The longitudinal construction joints shall be an approved key type joint with legs unless machine placed.

3.06 CONCRETE PAVEMENT PLACEMENT

- A. Set survey control stakes at 25 foot maximum spacing including high and low points. Additional staking may be required by the Engineer.
- B. The concrete shall be placed, consolidated, and finished to the widths and depths outlined in plans.
- C. Integral curbs shall be poured with the slab in a single paving machine operation. Normal mainline paving will not have construction joints at integral curbs.
- D. Concrete shall be deposited to the full depth of the pavement in a single operation.
- E. Necessary hand spading and spreading shall be done with shovels and not rakes.
- F. Place concrete to full depth in single operation. Keep a uniform pile of concrete in front of the paving machine, up to a maximum of 6 to 8 inches above the design surface elevation.
- G. The concrete shall be distributed and spread as soon as placed. A mechanical concrete spreader may be used.
- H. Concrete Screed:
 1. The concrete shall then be struck off and screeded by mechanical means.
 2. The striking off or screeding shall conform to the crown and cross section shown on the plans.
- I. The top of the forms shall be kept clean from accumulations of concrete, and the travel of the finishing machine on the forms shall be maintained true without lift, wobbling, or other variations tending to affect precision of finish.
- J. When finishing by hand methods, concrete shall be consolidated by use of vibrating units operating in the concrete. Unless the vibrating apparatus is such that the full width of concrete is consolidated in a single passage, a definite system or pattern shall be used in the operation of the vibrator so the full width of concrete in each linear foot of lane will receive adequate and uniform consolidation. The system and methods of vibrating shall be subject to approval the Engineer. Vibrating equipment shall

meet the requirements of IDOT Section 2301.07. Vibrating equipment shall, under no circumstances, be used as a tool for moving concrete laterally on the grade.

3.07 FINISHING

- A. Grade and Crown: Promptly after concrete has been placed and vibrated, the surface shall be struck off to the true section by the screed. The surface shall be finished true to crown and grade.
- B. Watering the Surface: The practice of lubricating the pavement surface with wet burlap or by sprinkling water from brushes or from sprinkler containers to afford greater ease in finishing operation shall not be allowed.
- C. Floats: Finish surface with wood or magnesium floats; finish from both sides simultaneously if pavement is placed to full width with one pass of paving machine.
- D. Straight Edging:
 - 1. After the longitudinal floating has been completed and the excess water has been removed, and while the concrete is still plastic, the slab shall be tested for trueness with a channel radius float, or approval equal. ("channel radius float" is manufactured by Owens Industries, Inc.)
 - 2. The channel radius float shall be held in successive positions parallel to the road center line in contact with the surface and the whole area worked from one side of the slab to the other as necessary.
 - 3. Advancement along the pavement shall be in successive stages of not more than one half the length of the channel radius float.
 - 4. Any depressions found shall be immediately filled with freshly mixed concrete, struck off, consolidated, and refinished.
 - 5. Check surface longitudinally while concrete is still plastic; correct any surface deviations greater than 1/8 inch in 10 feet. Round edges of pavement to 1/8 inch radius.
- E. Surface Treatment:
 - 1. Dragged Surface Treatment: Unless otherwise specified, the finished surface shall be textured with a dragged surface treatment
 - a. Astroturf or burlap shall be dragged longitudinally over the finished surface to produce a tight, uniform, textured surface, and the edges shall be rounded in a workmanlike manner.
 - b. The Astroturf or burlap drag shall be removed from the pavement surface at regular intervals and cleaned with water to remove accumulated concrete from the fabric in order to maintain a consistent finished texture.
 - c. When, for any reason, the desired texture normally obtained by the drag is not secured, the Engineer may require that the final finish be a broom finish, in lieu of or in addition to the drag.
 - 2. Light Sandblast Finish: Unless otherwise specified, for Integrally Colored Concrete, rub down or chip off and smooth fins or other raised areas 1/8 inch or more in height and provide light sandblast finish.
- F. Edge Finish: Before the concrete has taken its initial set, all edges of the slab shall be carefully finished with an edging tool and the pavement shall be left smooth and true to line and grade.

3.08 SURFACE CURING

- A. Apply liquid curing compound in a fine spray to form a continuous, uniform film on the horizontal surface and vertical edges of pavement, curbs and back of curbs immediately after surface moisture has disappeared, but no later than 30 minutes after finishing. With approval of the Engineer, the timing of cure application may be adjusted due to varying weather conditions and concrete mix properties to ensure acceptable macrotexture is achieved.
 - 1. Use a white pigment liquid curing compound for concrete not receiving an asphalt overlay.
- B. Apply compound with power sprayer; rate of application not less than 0.067 gallon per square yard (15 square yards per gallon); do not dilute compound.

- C. If forms are used, apply to pavement edges and back of curbs within 30 minutes after forms are removed.
- D. Protect concrete pavement during cold weather for at least 5 days, or protect a minimum of 24 hours and flexural strength of 500 psi. See Section 7010, 1.07.

3.09 JOINT SEALING

- A. Timing:
 - 1. Unless otherwise provided, before any portion of the pavement is opened to the Contractor's forces or to general traffic, joints that require sealing shall be sealed.
- B. Cleaning:
 - 1. For those joints that are not to be sealed, cleaning is not required.
 - 2. For those joints that are to be sealed, the residue from sawing shall be removed from the crack. An air compressor that provides moisture-free and oil-free compressed air shall be used. Removal of wet-sawing residue by flushing with high pressure water may be necessary prior to blowing the crack clean.
 - 3. Joint Sealer:
 - a. Joint sealer shall be prepared and installed in the joint and to the proper level as shown in the contract documents and as recommended by the manufacturer.
 - b. Hot-poured sealers shall be heated in a thermostatically controlled heating kettle; the material shall be heated to the temperature required for use, but not above that recommended by the manufacturer. After sealing, excess sealer shall be removed from the pavement surface.
 - c. Joint sealer shall be placed only when the pavement and ambient air temperatures are 40° or higher. When near this minimum, additional air blasting or drying time or both may be necessary to assure a satisfactory bond to the joint surfaces.
 - d. Joints shall be sealed the same day they are cleaned. Sealing shall be done only when the joint surfaces appear dry by visual examination.

3.10 FORM REMOVAL

- A. Timing:
 - 1. Forms shall not be removed before the initial set of the concrete has taken place.
 - 2. Remove stakes and forms with care to prevent cracking, spalling, or over stressing concrete. If damage does occur, the minimum repair shall be to saw cut full depth and remove a 4 by 2 1/2 feet wide area, dowel into adjoining sound concrete and pour back full depth; or per Engineer.
- B. Honeycomb Repair:
 - 1. When the side forms are removed, honeycomb shall be filled with mortar composed of 1 part cement and 2 parts fine aggregate by weight.
 - 2. If the honeycombing is to the degree and nature that it is considered by the Engineer as defective work, it shall be removed and replaced at the expense of the Contractor.
- C. Paving Protection: The area behind the curbs and slab shall be backfilled immediately after the forms are removed. Dams or other protection shall be constructed to insure that no saturation or erosion of the subgrade under or near the pavement shall occur. This may include check dams, pumping, etc.

3.11 DEFECTS OR DEFICIENCIES

- A. Pavement containing excessive cracks, fractures, spalls, or other defects shall be removed and replaced or repaired at no cost to Jurisdiction. Remedy to be determined by Engineer. In lieu of the above, the Engineer may approve an extended warranty.
- B. Pavement Thickness Deficiency: See SUDAS Section 7010, 1.08.
- C. Pavement Smoothness:

1. Local Streets & Minor Collectors: Finished pavements on local and minor collectors shall be checked with a 10 foot straightedge placed parallel to the center line. Areas showing high spots of more than 1/4 of an inch in 10 feet, shall be marked and ground down with an approved grinding tool to an elevation where the area or spot will not show surface deviations in excess of 1/8 inch when tested with a 10 foot straight edge. The surface corrections will follow the procedures of Iowa DOT Section 2316. The cost of correcting the smoothness and associated traffic control shall be incidental to the cost of pavement.

3.12 REMOVAL OF PAVEMENT

- A. Comply with Iowa DOT Section 2510.

END OF SECTION

32 17 23.13 - PAINTED PAVEMENT MARKINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Parking lot markings, including parking bays, crosswalks, arrows, handicapped symbols, curb markings, light pole bases.

1.02 RELATED REQUIREMENTS

- A. Section 32 13 13 - Concrete Paving.

1.03 REFERENCE STANDARDS

- A. MPI (APL) - Master Painters Institute Approved Products List; Master Painters and Decorators Association; current edition, www.paintinfo.com.
- B. FHWA MUTCD - Manual on Uniform Traffic Control Devices for Streets and Highways; U.S. Department of Transportation, Federal Highway Administration; <http://mutcd.fhwa.dot.gov>; current edition.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.

1.06 FIELD CONDITIONS

- A. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Pavement markings shall be only fast dry traffic lane marking paint conforming to Iowa DOT Standard specifications for Highway and Bridge Construction, Section 4183.03
 - 1. Parking lot striping, direction arrows, light pole bases, sidewalk curbs: White.
 - 2. Handicapped Symbols: White

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.

3.02 PREPARATION

- A. Allow new pavement surfaces to cure for a period of not less than 14 days before application of marking materials.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Clean surfaces thoroughly prior to installation.
 - 1. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods.
- D. Where oil or grease are present, scrub affected areas with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application; after cleaning, seal oil-soaked areas with cut shellac to prevent bleeding through the new paint.

3.03 INSTALLATION

- A. Do not apply paint if temperature of surface to be painted or the atmosphere is less than 50 degrees F or more than 95 degrees F.
- B. Apply in accordance with manufacturer's instructions using an experienced technician that is thoroughly familiar with equipment, materials, and marking layouts.
- C. Comply with FHWA MUTCD manual (<http://mutcd.fhwa.dot.gov>) for details not shown.
- D. Apply markings in locations determined by measurement from survey control points; preserve control points until after markings have been accepted.
- E. Apply uniformly painted markings of color(s), lengths, and widths as indicated on the drawings true, sharp edges and ends.
 - 1. Apply paint in one coat only.
 - 2. Wet Film Thickness: 0.015 inch, minimum.
 - 3. Length Tolerance: Plus or minus 3 inch.
 - 4. Width Tolerance: Plus or minus 1/8 inch.
- F. Parking Lots: Apply parking space lines, entrance and exit arrows, painted curbs, and other markings indicated on drawings.
- G. Symbols: Use a suitable template that will provide a pavement marking with true, sharp edges and ends, of the design and size indicated.

3.04 DRYING, PROTECTION, AND REPLACEMENT

- A. Protect newly painted markings so that paint is not picked up by tires, smeared, or tracked.

END OF SECTION

33 11 16 - SITE WATER UTILITY DISTRIBUTION PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Pipe and fittings for site water lines including domestic water lines and fire water lines.
- B. Valves, Fire hydrants, and Domestic water hydrants.

1.02 RELATED REQUIREMENTS

- A. Section 31 23 16 - Excavation: Excavating of trenches.
- B. Section 31 23 23 - Fill: Bedding and backfilling.
- C. Section 09 90 00 - Painting and Coating.

1.03 REFERENCES

- A. ASTM D 2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series); 2005.
- B. ASTM D 2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40; 2006.
- C. ASTM D 2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings; 1996 (Reapproved 2002).
- D. ASTM D 3139 - Standard Specification for Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals; 1998 (Reapproved 2005).
- E. AWWA C104/A21.4 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water; American Water Works Association; 2003 (ANSI/AWWA C104/A21.4).
- F. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; American Water Works Association; 2000 (ANSI/AWWA C111/A21.11).
- G. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast, for Water; American Water Works Association; 2002 (ANSI/AWWA C151/A21.51).
- H. AWWA C500 - Metal-Seated Gate Valves for Water Supply Service; American Water Works Association; 2002.
- I. AWWA C502 - Dry Barrel Fire Hydrants; American Water Works Association; 2005 (ANSI/AWWA C502/C502a).
- J. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service; American Water Works Association; 2001 (ANSI/AWWA C509).
- K. AWWA C900 or C909 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Distribution; American Water Works Association; 1997 (ANSI/AWWA C900/C900a).
- L. UL 246 - Hydrants for Fire-Protection Service; Underwriters Laboratories Inc.; 1993.

1.04 SUBMITTALS

- A. See Section 01 33 00 - Construction Submittals, for submittal procedures.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Project Record Documents: Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.05 QUALITY ASSURANCE

- A. Perform Work in accordance with SUDAS as amended by the Iowa City Supplemental Specifications.

PART 2 - PRODUCTS

2.01 WATER PIPE

- A. PVC Pipe: Comply with AWWA C900 Class DR-18 with gray iron pipe equivalent outside diameters.
 - 1. Fittings: Restrained mechanical joint complying with AWWA C110 (ductile iron or gray iron) or AWWA C153 (ductile iron). All bolts and nuts high strength low alloy corrosion resistant steel or stainless steel.
 - 2. Joints: All joints to be restrained.

2.02 VALVES

- A. Valves: Manufacturer's name and pressure rating marked on valve body.
- B. All valve boxes in paved areas or other areas shall be slide type.
- C. Gate Valves 3 Inches and Over:
 - 1. Comply with AWWA C509 (gray iron or ductile iron) and NSF 61 and in accordance with SUDAS as amended by the Iowa City Supplemental Specifications.

2.03 HYDRANTS

- A. In accordance with SUDAS as amended by the Iowa City Supplemental Specifications.

2.04 BEDDING AND COVER MATERIALS

- A. Comply with Iowa City Figure 3010.201, Sheet 3 of 6.

2.05 PIPELINE ACCESSORIES

- A. Polyethylene Wrap:
 - 1. Comply with AWWA C105.
 - 2. Provide tubes or sheets with 8 mil minimum thickness.
- B. Tracer System: Comply with Iowa City Figure 5010.102 to 5010.106
 - 1. Tracer Wire: # 12AWG solid single copper conductor.
 - a. Insulation material: Linear low-density polyethylene (LLDPE) installation suitable for direct burial applications.
 - b. Insulation Thickness: 0.045 inches, minimum.
 - 2. Ground Rod: 3/8-inch diameter, 60-inch steel rod uniformly coated with metallically bonded electrolytic copper.
 - 3. Ground-rod Clamp: High-strength, corrosion-resistant copper alloy.
 - 4. Splice Kit: See Tracer Wire Connector under the Accepted Products for Water Distribution Materials.
 - 5. Tracer Wire Station: See Tracer Wire Terminal Box under the Accepted Products for Water Distribution Materials.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that building service connection and municipal utility water main size, location, and invert are as indicated.

3.02 PREPARATION

- A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.
- B. Remove scale and dirt on inside and outside before assembly.

3.03 TRENCHING

- A. Hand trim excavation for accurate placement of pipe to elevations indicated.
- B. Form and place concrete for pipe thrust restraints at each change of pipe direction. Place concrete to permit full access to pipe and pipe accessories.
- C. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.04 INSTALLATION – PIPE

- A. Install piping and fittings.
- B. Route pipe in straight line.
- C. Install pipe to allow for expansion and contraction without stressing pipe or joints.
- D. Slope water pipe and position drains at low points.
- E. Install Tracer wire per Figure 5010.102, see drawings.

3.05 INSTALLATION - VALVES AND HYDRANTS

- A. Set valves on solid bearing.
- B. Center and plumb valve box over valve. Set box cover flush with finished grade.
- C. Set hydrants plumb; locate pumper nozzle perpendicular to and facing roadway.
- D. Set hydrants to grade, with nozzles at least 20 inches above ground.
- E. Provide a drainage pit 36 inches square by 24 inches deep filled with 2 inches washed gravel. Encase elbow of hydrant in gravel to 6 inches above drain opening. Do not connect drain opening to sewer.
- F. Tracer wire shall per SUDAS as amended by the Iowa City Standard Specifications.

3.06 SERVICE CONNECTIONS

- A. Provide water service in accordance with the Iowa City Standard Specifications.

3.07 TESTING

- A. All testing shall be in accordance with the Iowa City Standard Specifications.

3.08 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Section 01 40 00.
- B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to the Owner.

END OF SECTION

