SECTION 23 00 00

HVAC GENERAL

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Refer to Division 1 - General Requirements and any and all Supplementary or Special Requirements, all of which apply to work described in Division 23 - HVAC as if written in full herein.

B. The scope of work described in these Specifications and/or indicated on the Drawings shall include the furnishing of all materials, equipment, appurtenances, accessories, connections, labor, etc. required and/or necessary to completely install, clean, inspect, adjust, test, balance and leave in safe and proper operating condition all HVAC systems. All HVAC work shall be accomplished by workmen skilled in the various trades involved.

C. The Drawings and Specifications are complementary to each other and what is called for by one shall be as binding as if called for by both. If a discrepancy exists between the Drawings and Specifications, the higher implied cost shall be included in the bid, and the Architect shall be notified of the discrepancy in writing.

D. All work performed under this specification shall be accomplished in accordance with the requirements and provisions of the following sections:

1. Section 01 81 13 Sustainable Design Requirements
2. Section 01 91 00 Commissioning

1.2 CODES AND STANDARDS

A. All HVAC work shall conform to all ordinances and regulations of the City, County and State where the work will take place, including the requirements of all authorities having jurisdiction. The following codes, standards and references shall be observed as a minimum:

1. The 2021 International Codes
2. Denver Amendments to the Code
3. National Fire Protection Association (NFPA) Standards and Guidelines
4. Local and State Fire Marshal requirements
5. Local Building and Inspection Department requirements
6. Local adopted codes, standards, ordinances (including noise ordinances), or amendments
7. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE)
    a. Standard 90.1-2019 – Energy Standard for Buildings Except Low-Rise Residential Buildings
    b. Standard 62.1-2019 – Ventilation for Acceptable Indoor Air Quality
    c. Standard 62.2-2019 – Ventilation and Acceptable Indoor Air Quality in Residential Buildings
    d. Other Standards and Guidelines as applicable
8. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA) Manuals
9. Air Conditioning, Heating, and Refrigeration Institute (AHRI)
10. Air Conditioning Contractors of America (ACCA)
11. Home Ventilating Institute (HVI)
12. American National Standards Institute (ANSI)
13. American Society of Mechanical Engineers (ASME)
14. Underwriters Laboratories Inc. (UL)
15. Americans with Disabilities Act (ADA)

16. National Green Building Standard (NGBS)

B. If Code or other requirements exceed the provisions shown on the Contract Documents, the Engineer shall be notified in writing. Where requirements of the Contract Documents exceed Code requirements, work shall be furnished and installed in accordance with the Contract Documents. Any work done contrary to these requirements shall be removed and replaced at the Contractor's expense.

1.3 NOISE CRITERIA DESIGN GOALS

A. Mechanical equipment, air distribution systems and devices shall be designed to not exceed the following noise criteria (NC) levels:

1. Public Space Areas: NC <35
2. Utility/All Other Areas: NC <40
3. Residences, Apartments, Condominiums:
    a. Living areas (including Bedrooms: NC 30
    b. Bathrooms, Kitchens, Utility Rooms: NC-35

1.4 MISCELLANEOUS DEFINITIONS

A. Terms: The following definitions of terms supplement those of the Division 01- General Requirements and are applicable to Division 23 – Heating, Ventilation, and Air Conditioning (HVAC):

1. Contractor: As used herein the term shall mean "the person or entity referred to throughout the Contract Documents as if singular in number. The Contractor shall designate in writing a representative who shall have express authority to bind the Contractor with respect to all matters under this Contract. The term "Contractor" means the Contractor or the Contractor's authorized representative."
2. Furnish: As used herein shall mean "supply and deliver to Project site, unload and inspect for damage."
3. Install: As used herein the term shall mean "to place in position for service, temporarily store, unpack, assemble, erect, apply, place, protect, clean, start up, and make ready for use."
4. Owner: As used herein the term shall mean "the person or entity identified as such and is referred to throughout the Contract Documents as if singular in number. The Owner shall designate in writing a representative who shall have express authority to bind the Owner with respect to all matters requiring the Owner's approval or authorization. The term "Owner" means the Owner or the Owner's authorized representative."
5. Product: As used herein shall include materials, systems, and/or equipment, machinery, components, and fixtures forming the work result. Not materials or equipment used for preparation, fabrication, conveying, or erection and not incorporated into the work result. Products may be new, never before used, or re-used materials or equipment.
6. Provide: As used herein shall mean "furnish and install, complete and ready for the intended use."
7. The Work: As used herein the term shall mean "the construction and services required by the Contract Documents, whether completed or partially completed, and includes all other labor, materials, equipment, and services provided or to be provided by the Contractor to fulfill the Contractor's obligations. The Work may constitute the whole or a part of the Project.
8. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.5 WORK INCLUDED

SECTION 23 00 00

HVAC GENERAL

The HVAC Systems installed and work performed under this Division of the Specifications shall include, but not necessarily be limited to:

A. Airside Systems

1. Equipment: including fans, unitary air conditioners, air handling units, fan-coil units, make-up air units, dedicated outdoor air units, furnaces, split systems, etc.
2. Ductwork and Accessories: including sheet metal, duct-board, kitchen hood and dishwasher exhausts, flexible ductwork, fire and smoke dampers, access doors, etc.
3. Air Terminal Devices: including fan powered induction units, variable air volume valves, etc.
4. Air Distribution Devices: including louvers, registers, grilles, diffusers, etc.

B. Refrigerant and Water Systems

1. Equipment: including pumps, air separators, expansion tanks, water chillers, cooling towers, filtration systems, chemical treatment, heat exchangers, boilers and space heating water heaters, feed-water systems, condensing units, etc.
2. Piping, Tubing and Accessories: including pipe, refrigerant tubing, valves, solenoids, thermal expansion valves, strainers, air vents, pipe and equipment drains, condensate drains, expansion devices, etc.
3. Complete factory installed UL listed A2L refrigerant detection and mitigation system for each refrigerant based system.

C. Equipment, Ductwork and Piping Supports

1. Equipment Mounts: including roof curbs, concrete housekeeping pads, equipment rails, miscellaneous steel, etc.
2. Hangers and Support Devices: including inserts, hanger rods, strut channel, cross-bracing, anchor bolts, pipe anchors, restraints, etc.
3. Vibration Isolation and seismic restraint: including inertia bases, flexible couplings, expansion devices, snubbers, springs, waffle pads, seismic restraints, etc.

D. Insulation

1. Ductwork Insulation: including exterior duct wrap, internal duct liner, fire wrap, etc.
2. Piping and Equipment Insulation: including preformed, board and wrap.

E. Miscellaneous HVAC Equipment: electric heaters, roof hoods, heat tracing, etc.

F. Fuel oil storage and distribution systems

G. Automatic Temperature Controls

1. Decentralized: including all thermostats, control dampers, control valves, programmable controllers, line and low-voltage wiring, smoke detectors, pressure sensors, gas sensors, control logic, etc.

H. Labor and Equipment: including project management, supervision, tradesmen, lifts, fork-trucks, cranes, scaffolding, saws, wrenches, etc.

I. Equipment and Valve Identification

J. Start-up and Commissioning

K. Demonstration and Owner Training

L. Testing, Adjusting and Balancing

1.6 ENGINEER'S DRAWINGS

A. The locations, arrangement and extent of equipment, devices, ductwork, piping, and other appurtenances related to the installation of the HVAC work shown on the Drawings are approximate and define the intent of the design. The Contractor shall not scale Engineer's Drawings, but shall refer to the architectural drawings for exact dimensions of building components. Should a conflict exist between the architectural and engineering drawings regarding dimensions and scale, the Contractor shall notify the Architect of the discrepancy.

B. Materials, equipment or labor not indicated but which can be reasonably inferred to be necessary for a complete installation shall be provided. Drawings and Specifications do not undertake to indicate every item of material, equipment, or labor required to produce a complete and properly operating installation.

1.7 EQUIPMENT, MATERIALS AND BID BASIS

A. Manufacturers' names, model numbers, etc. cited on the Drawings and in the Specifications are for the purpose of describing type, capacity, function and quality of equipment and materials required. All project design and coordination between disciplines has been performed as if the named manufacturer and specific piece of equipment will be provided to the project by the Contractor.

B. Alternate equipment and/or materials other than that named on the Drawings and in the Specifications may be proposed for use, but all equipment and materials shall conform entirely to the specified base items. Proposed alternate equipment shall be substantially equal in size, weight, construction and capacity. Alternate equipment and materials shall be submitted only as full equivalent to the equipment and materials specified, with sufficient supportive documentation and technical literature to demonstrate quality, performance, and workmanship without doubt or question. Requests for prior approval of alternate products shall be made at least ten (10) days prior to the bid date and as required by Division 1 - General Requirements. The Engineer shall consider the use of the alternate equipment based on the supportive documentation made available to him, and shall approve or disapprove any proposed alternates. Major exceptions to these specifications will be considered sufficient cause for rejection of the submittal. The decision of the Engineer shall, in all cases, be final.

1. The ten (10) day prior approval submittal shall include a Compliance Review of the Specifications and Addenda (if any). The Compliance Review shall be paragraph-by-paragraph review of the Specifications with the following information; "C", "D" or "E" marked in the margin of the original Specifications and any subsequent Addenda.
2. "C": Comply with no exceptions.
3. "D": Comply with no deviations. For each and every deviation, provide a numbered footnote with reasons for the proposed deviation and how the intent of the Specification can be satisfied.
4. "E": Exception, does not comply. For each and every exception, provide a numbered footnote with reasons and possible alternatives.
5. Manufacturer shall provide complete paragraph-by-paragraph compliance document detailing unit conformance to the specification. The Engineer will not review the proposal for equipment compliance.

Unless a deviation or exception is specifically noted in the Compliance Review, it is assumed that the bidder is in complete compliance with the plans and specifications. Deviations or exceptions taken in cover letters, subsidiary documents, by omission or by contradiction do not release the bidder from being in complete compliance, unless the exception or deviation has been specifically noted in the Compliance

Review. The bidder may submit the latest state-of-the-art components in lieu of specified components at no additional cost, where latest state-of-the-art components perform better than what is specified. All deviations from the specifications must be approved by the Architect/Engineer and the Owner.

C. The Contractor shall coordinate the installation of all HVAC equipment proposed for use in this project with all building trades (architectural, structural, electrical, etc.). Coordination shall be accomplished prior to, and shall be reflected in, the equipment submittals for approval. When the Contractor requests substitution of alternate equipment, it is with the knowledge that he shall be responsible for any and all costs required by the substitution, including necessary engineering and construction revisions in his or any other contract or trade to satisfy the design intent shown on the Plans and described in the Specifications.

D. All materials exposed within HVAC plenums shall have a flame-spread index of not more than 25 and a smoke-developed rating index of not more than 50 unless otherwise allowed by code.

1.8 SUBMITTALS

A. The Contractor shall prepare, submit, and obtain Engineer's review of all manufacturers' data on the HVAC equipment and systems prior to ordering, purchasing, or installing any equipment or materials. Shop drawings shall be submitted electronically in a portable document format (pdf). Submittals shall be as described in Division 01 - General Requirements. Prior to submitting to the engineer, the contractor shall review and subsequently place his approval stamp on the shop drawings indicating conformance with the contract documents. Submittals shall be transmitted simultaneously in a single .pdf file per specification section and the items submitted clearly identified. The engineer will review the submittals one time for conformance with the contract documents and return them with their approval stamp indicating "Reviewed", Reviewed as Noted", "Returned for Corrections-Resubmit", "Rejected, See Comments" or "Reviewed for Coordination Only". For submittals requiring a resubmittal, one additional review will be performed at no charge. Subsequent re-reviews will be made after the engineer notifies the Architect/Owner that an hourly charge will occur for time expended performing the re-review. Submittals lacking the contractor's approval stamp and partial submittals will be returned without review. Submittals, as a minimum, shall include:

1. All HVAC items scheduled on the Drawings
2. Equipment arrangement, ductwork and piping drawings. Contractor drawings shall be prepared at a minimum scale of 1/8" = 1'-0". A scale of 1/4" = 1'-0" scale is preferred. Drawings shall be indicative of actual equipment purchased and shall show all offsets, transitions, fittings, dampers, valves, hanger locations, etc. Sections are required in spatially tight areas (e.g. kitchens, laundries, central plants, mechanical rooms, etc.) The following will guide the Contractor as to minimum drawing detail required:
    a. Clearly indicate top and bottom of duct and pipe elevations. All elevations shall be coordinated as to not conflict with structural, plumbing, electrical and architectural trades.
    b. Indicate all offsets (both vertical and horizontal).
    c. Indicate graphically all duct and pipe joints and their lengths.
    d. Submit duct and pipe-work fabrication schedule indicating duct size range with minimum duct material gauges, pipe schedule being used, duct and pipe connection joint types, section lengths, duct reinforcement type and spacing, etc.
    e. Indicate graphically all ductwork to be fabricated with internal duct liner.
    f. Indicate all insulation for ductwork and piping.
    g. Indicate all dampers and valves as shown on design documents and called for in the specifications.
    h. Indicate all flexible connectors where required by specifications and notes.
3. Flexible ductwork, duct-board, insulation and linings

4. Ventilation controllers, dampers, louvers, air distribution devices, wall terminations (wall caps), roof terminations (roof caps, hoods, jacks, etc.)
5. Manufacturer's cut sheets of all piping and tubing materials
6. Where split systems are used in a "long line application," submit manufacturer's refrigerant line set routing drawings and engineered calculations supporting installed line lengths and recommended suction and liquid line sizes (deviations in the installed lengths and sizes shall be recorded on the as-built drawings and coordinated with the manufacturer to reconfirm that long line guidelines are being met).
    a. Identify and provide cut sheets of any and all accessories required to make the system complete, functional and reliable.
    b. Any split system with 75 feet of separation between the outdoor unit and the indoor unit requires that the contractor obtain a warranty approval letter from the equipment manufacturer certifying the long line length distances shown on the submitted shop drawings are acceptable.
    c. Refer to the EQUIPMENT INSTALLATION - COMMON REQUIREMENTS paragraph below.
7. Refrigerant type and charge (lbs.) for each item of equipment utilizing refrigerant.
8. Refrigerant Detection and Mitigation systems and/or components.
9. AHRI Certificates
10. Valves, thermometers, pressure gauges
11. Thermal expansion/contraction piping system design including complete layout drawings indicating anchor loads, points, and method of structural support.
12. Roof curbs, equipment supports, hanger systems, vibration isolators, seismic restraints
13. Control equipment, systems and diagrams
14. Test and balance reports

B. All submittal approvals required by any code or enforcement authority, insurance underwriter, etc. shall be obtained prior to being submitted to the Engineer.

C. Review of submittals by the Engineer does not relieve the Contractor from responsibility for complying with all requirements of the Contract Documents. Furthermore, it shall be the responsibility of the Contractor to coordinate the requirements (roof penetrations, wall penetrations, floor penetrations, curbs, electrical, etc.) of all approved equipment with the other trades and disciplines.

D. All submittals shall be identified by the equipment mark or tag identification numbers shown on the Contract Drawings. Each individual submittal item shall be marked to show which specification section pertains to the item.

E. The Contractor shall provide a written statement confirming coordination of voltage requirements for all HVAC equipment requiring an electrical connection. Statement shall bear the names and signatures of the HVAC and electrical contractors. A photocopied reproduction of the below statement is acceptable. Failure to include a written statement confirming the voltage requirements have been coordinated between the Mechanical and Electrical Contractors may result in the submittal being returned without review.

VOLTAGE COORDINATION STATEMENT

This statement is to confirm that the voltages of the equipment provided under this specification have been coordinated with the Electrical Drawings, as well as with the Electrical Contractor.

HVAC Contractor: _____

Project Manager Name: _____

Project Manager Signature/Date: _____
Electrical Contractor: _____
Project Manager Name: _____
Project Manager Signature/Date: _____

1.9 PERMITS

A. The Contractor shall obtain all permits and inspections required for the installation of the HVAC work and pay all charges incident thereto. He shall deliver copies of all certificates of permit and inspection to the Architect.

1.10 COORDINATION OF TRADES

A. The Contractor shall give full cooperation to other trades, and shall furnish all information necessary to permit the work of all trades to be installed satisfactorily and with the least possible interference or delay.

B. Piping and other HVAC equipment shall not be installed without first coordinating the installation of same with other trades. The Contractor, at his own expense, shall relocate all uncoordinated ductwork, piping and other HVAC equipment installed should they interfere with the proper installation and mounting of electrical, plumbing equipment, ceilings and other architectural or structural finishes.

C. The Contractor shall coordinate the elevations of all ductwork, piping and equipment above ceilings and in exposed areas with the work of all other disciplines prior to installation.

D. In areas where more than one trade is required to use common openings in beams, joists, chases, shafts and sleeves for the passage of conduits, raceways, piping, ductwork and other materials, the Contractor must coordinate the positions of all piping and equipment to be furnished under this section so that all items including the materials and equipment of other trades may be accommodated within the space available.

E. The HVAC Contractor shall confirm that his work does not interfere with the clearances required for finished columns, pilasters, partitions, walls or other architectural or structural elements as shown on the Contract Documents.

F. Work that is installed under this Contract which interferes with the architectural design or building structure shall be removed and relocated as required at no additional cost to the Contract.

G. Coordinate power and fire alarm requirements of all combination fire/smoke dampers and smoke dampers with the electrical contractor.

H. The General Contractor shall coordinate service access paths for roof-mounted equipment requiring routine maintenance. Provide code compliant galvanized steel crossing structure (e.g. stairs with handrails, ladders, etc.) for any obstruction (ductwork, piping, etc.) that exceeds 1'-6" in height x 1'-6" in width. In addition, refer to Part 3 below - EQUIPMENT INSTALLATION - COMMON REQUIREMENTS. Details of such crossings shall be included with piping and ductwork layout and coordination drawings.

I. Coordinate with the roof system used so that a minimum of 8" of the roof curb is above the finished roof for flashing purposes. The top of the curb shall be level and the slope of the roof shall be compensated for by the curb.

1.11 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall prepare a minimum of two (2) instruction manuals, one of which shall be submitted to the Architect for the Engineer's review. Manuals shall describe installation, operation and maintenance of all HVAC equipment and shall include copies of control schematics, sequences of operation, function and operations of all components, as well as the Contractor's name, address, and telephone number. Manuals shall also contain one copy of all manufacturers' drawings, pamphlets, data, parts lists, and instruction manual for each piece of equipment. Upon approval, one copy shall be delivered to the Owner; one copy shall be kept by the Contractor. The pamphlets and drawings are to be neatly bound in (a) 3-ring binder(s). In addition to the hard copy, provide electronic files (PDF format) of the manuals.

1.12 AS-BUILT DRAWINGS

A. The Contractor shall maintain a record of all changes in the work from that shown in the Contract Documents. The record shall be by red-line mark-up on the most current set of Engineer's Drawings kept in the field office. After all work is completed, the Contractor shall prepare a set of "as-built" reproducible drawings of similar type and quality as the Engineer's Drawings. As an alternate to hard copy drawings, provide electronic files (PDF format) of the as-built conditions. As-built drawings shall accurately depict actual final arrangement of all HVAC items. As-built drawings shall be delivered to the Architect.

1.13 WARRANTY

A. All equipment furnished and installed under this Contract shall be provided with the manufacturer's standard warranty unless otherwise noted.

B. All reciprocating, rotary and scroll air conditioning compressors shall be provided with an extended 5-year parts warranty.

C. The Contractor shall make good all defects in material, equipment, or workmanship disclosed within a period of one (1) year from date of building acceptance by the Owner. The phrase "make good" shall mean to furnish promptly, without charge, all work necessary to remedy the defects to the satisfaction of the Engineer.

1.14 COMMISSIONING

A. This project requires commissioning per the requirements of the 2021 IECC. Commissioning shall be by applicable contractor and either the engineering firm of record or a 3rd party commissioning agent. Refer to the commissioning (specifications, plan, checklists, and/or additional on drawing notes) for additional information.

PART 2 - PRODUCTS

2.1 GENERAL

A. All equipment, materials, accessories, etc. used shall be new and of current production unless specified otherwise. Equipment not specified in the Engineer's Drawings shall be suitable for the intended use and shall be subject to approval by the Engineer.

B. All equipment, products and materials shall be free of defects and shall be constructed to operate in a safe manner without excessive noise, vibration, leakage, or wear.

C. All equipment shall bear the inspection Label of Underwriters Laboratories Inc.

D. All equipment and material for similar applications or systems shall be provided from the same manufacturer unless noted otherwise.

E. The VOC content of all products in this section shall not exceed the VOC limits established in Section 01 81 13 Sustainable Design Requirements.

F. VOC Content: Submit adhesive and sealants product information or MSDS showing VOC Content information for all applicable products specified under this section. All applicable products in this section must meet low VOC content as specified by LEED Specification Section 01 81 13 Sustainable Design Requirements.

2.2 ELECTRICAL WORK

A. Except as otherwise specified or noted, electrical equipment used for HVAC systems shall be as specified herein.

B. Motor controls, system controls, starters, disconnects, pilot lights, push buttons, etc. shall be furnished by the HVAC Contractor compatible with the apparatus that it operates. Electrical equipment shall be wired for the voltage shown on the Electrical Drawings.

C. The Contractor shall be responsible for coordinating and furnishing equipment of voltage shown on the electrical documents.

D. Electric motors shall be NEMA Premium Efficiency open drip proof type. Motors shall meet NEMA MG1 Tables 12-11 and 12-12 of EISA, 2021. Motors shall be selected with a minimum of 15% safety factor greater than the fan brake/horsepower (e.g. 4.75 BHP would require a nominal 7½ HP motor). The motor service factor shall not be used as part of the safety factor. All motors shall have thermal overload protection. Motors shall be capable of operating at $\pm$ 10% of the design voltage without voiding the manufacturer's warranty. Motors that drive equipment that will run continuously shall be IEC 60034-1 continuous duty rated.

E. Motors controlled by a variable frequency drive (VFD) shall be inverter duty motors designed according to the requirements of NEMA MG 1, Part 31, "Definite Purpose, Inverter Fed Motors" and shall be compatible with the particular manufacturer's drive that is used.

F. Starters for motors ⅓ HP and smaller shall be manual type, and for ½ HP and larger, shall be magnetic type. Starters shall be minimum size 0, combination type (with disconnect and lockable handle) with molded case circuit breaker. Starters for motors with remote or automatic control shall be magnetic. Relays, interlocks and auxiliary contacts shall be provided as specified and required.

G. Magnetic motor starters shall be across-the-line, full voltage, non-reversing type unless otherwise indicated on the Drawings or specified herein. Starters for motors 75 HP and greater shall be solid state, reduced voltage type.

H. Motor controls shall be either "Hand-Off-Auto" switches or "On-Off" push buttons with one indicating light. "Hand-Off-Auto" switches shall be provided for automatically controlled apparatus.

I. Motor starters that are not an integral part of HVAC equipment shall be installed in conformance with Division 26 - Electrical Requirements.

J. All "loose" disconnects and starters shall be installed by Division 26.

K. Power wiring to disconnects, starters, and equipment shall be provided and installed by Division 26. All equipment requiring electrical power shall be provided with a disconnect switch at each piece of equipment. Coordinate switch type (fused or non-fused) with equipment characteristics, manufacturer's recommendations and the electrical drawings.

L. Provide all system controls and associated control and interlock wiring for complete and operable systems. 120 volt and higher wiring shall be MC cable or in conduit in accordance with local codes and the materials and installation requirements of Division 26 - Electrical.

M. Coordinate power and fire alarm requirements of all combination fire/smoke dampers and smoke dampers with the electrical contractor.

N. All starters and variable frequency drives shall be labeled on the face of the device with a semi-rigid plastic laminate nameplate with 1" high white letters on a black background securely affixed to the equipment. The label shall indicate equipment served (equipment tag used on the Drawings). Labels shall be furnished and installed by the Contractor.

O. All starters for 3-phase equipment shall have overload devices in each phase.

P. Wiring diagrams shall be furnished by the Contractor.

Q. Coordinate with the electrical drawings for the calculated available fault current at the panelboard serving multi-motor and combination-load equipment or the calculated available fault current indicated at the equipment. This fault current value shall be utilized to determine the correct Short Circuit Current Rating (SCCR) for the equipment. The equipment nameplate shall bear a rating of no less than the panelboard rating or the calculated fault current.

R. Acceptable manufacturers shall be General Electric, Square D, Eaton, Siemens and Allen Bradley.

2.3 AIR FILTERS

A. All filters shall be U.L. 900 classified.

B. Filters shall be pleated disposable type (MERV 6 minimum) unless specified otherwise.

C. Install one set of new filters in air handling equipment during construction and install a new set prior to test and balance. Fan powered induction units shall have a temporary roll filter media installed at the plenum air inlet during construction. Remove temporary filter media prior to test and balance. Clean and vacuum all inlets prior to test and balance.

D. Temporary roll filter media shall be provided at the inlets to all air handling equipment operated during construction. Remove temporary filter media prior to test and balance. Clean and vacuum all inlets prior to test and balance.

3.1 STORAGE AND PROTECTION OF STORED MATERIALS

A. During construction, all equipment shall be properly protected against damage, defacing and freezing with shipping cartons, plastic sheeting, shipping covers, etc.

B. All open ends of piping and equipment shall be sealed with nipples and caps, plugs, and test plugs until final connection to system is made.

C. All equipment, piping and ductwork shall be protected to prevent entrance of foreign matter and debris by covering exposed openings during construction.

D. Handle and store materials in accordance with manufacturer's and supplier's recommendations and in a manner to prevent damage to materials during storage and handling. Replace damaged materials.

E. Equipment and materials shall not be installed until such time as the environmental conditions of the job site are suitable to protect the equipment or materials. Equipment or materials damaged, or which are subjected to these elements, are unacceptable and shall be removed from the premises and replaced.

3.2 PROTECTION OF HVAC SYSTEMS IN OCCUPIED BUILDINGS

A. Protect equipment and air distribution systems as outlined in SMACNA's IAQ Guidelines for Occupied Buildings Under Construction, latest edition.

3.3 BUILDING DRY-OUT DURING CONSTRUCTION

A. HVAC equipment shall not be used to dehumidify the building interior and dry-out construction materials. The HVAC system does not have the capacity to perform a building dry-out. The HVAC equipment shall not be operated until the building is completely dried-in and construction is substantially complete.

B. Coordinate with the general contractor to provide industrial grade desiccant type dehumidifiers to perform building dry-out. Propane or diesel space heaters are not acceptable as the combustion process adds moisture to the air.

3.4 CUTTING, PATCHING, AND SEALING

A. The work shall include all cutting and patching required as part of the HVAC installation. Refer to Division 1 - General Requirements.

B. All penetrations in walls, ceilings, and partitions required by mechanical work shall be sealed with an appropriate pliable sealant or fire caulking to make the penetration airtight. Penetrating items shall include, but not be limited to, ductwork, piping, conduit, cables, control wiring (especially for thermostats and sensors), hangers, mounting hardware, etc.

3.5 CONCRETE WORK

A. Construct curbs, pads and similar supports for equipment where required.

B. Provide 4" (min.) thick housekeeping pads for all floor mounted equipment, extending 6" beyond the area occupied by the equipment. Dowel pads to structural slab.

C. Perform concrete work in accordance with applicable portions of Division 3 - Concrete. Minimum compressive strength of concrete shall be same as specified for slabs on grade.

D. Mix and install grout for HVAC equipment base bearing surfaces and anchors. Provide forms as necessary and place grout to completely fill equipment bases.

3.6 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

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

D. Install equipment to allow right-of-way for piping to be installed with the required slope.

E. For roof and attic mounted equipment requiring routine maintenance, allow for an unobstructed path from the roof/attic service entry point to the equipment. The path area shall be a minimum of 6'-0" high by 3'-0" wide.

F. Split system outdoor unit equipment has been shown indicating matched systems of the indoor unit with its associated outdoor unit. While the location of the outdoor units are approximate, the importance of unit locations relative to the refrigerant line set penetration through a wall or roof is critical for the project. Prior to ordering equipment, the contractor shall carefully coordinate the line set routing and requirements with the split system manufacturer to insure installation guidelines, especially for long line applications, are being followed. Refrigerant line sets shall be routed to reduce the system total equivalent length and minimize system capacity losses due to elbows, fittings, valves, etc. After the coordinated routing drawings have been approved and certified by the split system manufacturer, they shall be submitted for review along with the equipment and any required accessories. During installation, the contractor is responsible for keeping as-built refrigerant piping installation drawings noting any deviations to the proposed routing. Deviations that may affect proper system operation or performance shall be reviewed by the manufacturer immediately and corrective action implemented as required.

3.7 EQUIPMENT SUPPORTS

A. Major equipment supports (structural steel frames, framed structural slab and wall openings, etc.) shall be furnished and installed by others; however, the HVAC work shall include furnishing and installation of all miscellaneous equipment supports, structural members, rods, clamps and hangers required to provide adequate support of all HVAC equipment.

B. Unless otherwise shown on the Drawings, all HVAC equipment, piping, and accessories shall be installed level, square, and plumb.

C. All equipment, piping, etc. supported by structural bar joists shall be supported only by the top chord of the joists. Hangers shall not be attached to the bottom chord of any joists.

3.8 PIPE AND DUCTWORK PENETRATIONS

A. Sleeves shall be installed in all masonry or concrete walls, floors, roofs, etc. for pipe and ductwork penetrations. Sleeves for pipe shall be schedule 40 black steel pipe. Sleeves for ductwork shall be 20-gauge galvanized steel. Ductwork sleeves shall be sized to provide a minimum of ¼" clearance between the sleeve and duct. For insulated ducts, the clearance shall be between the sleeve and the insulation.

B. As far as possible, all pipe and ductwork penetrations shall be provided for at the time of masonry or concrete construction. Where drilling is required, only core drills shall be used. Star drills shall not be used.

C. Piping entering the building below grade and passing through cast-in-place concrete walls or floors shall be fitted with a mechanical rubber seal inside of a 12" long schedule 40 steel pipe sleeve with integral water-stop. The sleeve shall be sized to house the mechanical rubber seal and carrier pipe.

The mechanical rubber seal shall be constructed of EPDM and stainless-steel hardware and provide a hydrostatic seal of up to 20 psi and up to 40 feet of head. Products shall be Metraseal as manufactured by The Metraflex Company or equal by Link-Seal.

D. All pipes passing through masonry walls shall be fitted with schedule 40 steel pipe sleeves. Sleeves shall be of the first possible size larger than the outside diameter of the pipe to be sleeved or the insulation jacket on covered pipes. Sleeves shall be flush on either side of the masonry walls.

E. All pipes passing through the masonry floors shall be fitted with schedule 40 steel pipe sleeves of the first size larger than the pipe to be sleeved. All sleeves on these floors shall extend 1" above the finished floor and 1" below the bottom of the slab. All pipe sleeves through the floors of the mechanical room shall be 16-gauge galvanized steel extending 2" above the finished floor. After the pipes are installed, the annular space shall be packed with fiberglass to ½" from the top of the sleeves, and then topped off with a ½" depth of sealant such as PRC-Rubber Caulk 7000 or other such approved sealant.

F. All pipes penetrating walls or floors of any construction shall be installed with escutcheon plates on both sides of the penetration securely fastened to the wall or floor with a clamping device for holding the escutcheon in position.

G. In exposed areas, escutcheon plates shall be chrome plated. All escutcheon plates shall be sized to completely conceal the penetration.

H. Ductwork penetrating walls or floors of any material shall be installed with closure plates on both sides of the penetration.

I. All pipe and duct penetrations of fire, smoke, or fire and smoke-rated assemblies shall be fire-stopped as required to retain the integrity of the UL-rated assembly. Fire barrier products shall be as manufactured by Tremco, Hilti, 3M, Metacaulk, Nelson, STI or approved equal. Refer to Division 7 - Thermal and Moisture Protection.

J. Ensure that materials used for fire-stopping, caulking, sealing, pest/rodent proofing, etc. are compatible with the piping material used. Some materials are known to react with certain piping systems causing premature failure.

3.9 FLASHING

A. All piping and ductwork penetrating roofs shall be flashed in an approved manner, shall be watertight, and shall conform to the requirements detailed in Division 7 - Thermal and Moisture Protection.

3.10 EQUIPMENT LABELING

A. All HVAC equipment shall be labeled. This shall include all central plant, air handling or air conditioning equipment, air terminals, and other similar and miscellaneous equipment.

B. Labels for air terminals or other devices shall be located for optimum visibility through access panel or removed ceiling tiles.

C. Equipment labeling shall be one of the following, unless noted or specified otherwise:

1. Permanently attached plastic laminated signs with engraved 1" high lettering
2. Stencil painted identification, 2" high letters, with standard fiberboard stencils and standard black (or other appropriate color) exterior stencil enamel

D. Labels, stencils, and signs shall be legible, UV resistant and constructed to be long lasting.

3.11 CLEANING

A. At all times, the premises shall be kept reasonably clean and free of undue amounts of waste, trash and debris by periodic cleaning and removal. After completion, all foreign material, trash and other debris shall be removed from the job site.

B. After all equipment has been installed, but prior to testing and balancing, all equipment, piping, ductwork, etc. shall be thoroughly cleaned both inside and out.

C. After cleaning, filters shall be installed where required and all systems shall be tested and balanced.

D. After testing and balancing and just prior to Owner review and acceptance, all systems shall be finally cleaned and left ready for use.

3.12 PAINTING

A. Painting will be done under Division 9 - Painting except as otherwise noted, but the HVAC Contractor shall leave all surfaces of work free of rust, dirt and grease.

B. The HVAC Contractor shall touch-up any equipment scratched in shipment or during installation to match the original finish. Touch-up painting of HVAC equipment shall be part of the HVAC work.

C. Any visible ductwork through grilles, registers and diffusers shall be painted flat black.

D. Provide one coat of rust preventive primer on all new structural steel supports and new ferrous surfaces not galvanized, including insulated and non-insulated HVAC piping. Rust preventive painting shall be part of the HVAC work. Rust preventive paint shall be “Rust Destroyer” by Advanced Protective Products, Inc., Fair Lawn, NJ, (800) RUST-007. Product shall have a 5-year warranty when applied directly over rust. Clean and prepare surface per manufacturer’s recommendations.

E. All painting and coating shall match the original finish and shall conform to the requirements detailed in Division 9 - Finishes.

F. Do not paint over equipment nameplates, nonferrous hardware, accessories or trim.

3.13 PERFORMANCE AND DEMONSTRATION TESTS

A. All testing and demonstration of any and all HVAC systems required for acceptance by any authorities having jurisdiction shall be included as part of the HVAC work. This shall include the furnishing of any and all testing equipment, smoke generation devices, and any other required equipment or accessories, and all necessary labor required to perform any required tests or demonstrations. The Contractor shall coordinate and verify all devices, equipment and sequence of testing and/or events with such authorities having jurisdiction. The Contractor shall perform a minimum of two (2) satisfactory preliminary tests or demonstrations prior to any formal tests and/or demonstrations for any code authorities and shall give a minimum of five (5) days advance notice to the Engineer of any and all preliminary tests and/or demonstrations, indicating the date and time of such tests.

3.14 TRAINING

A. Upon completion of the work, the Contractor shall conduct operation and training session(s) for the Owner’s key operating personnel. These sessions shall be of sufficient length and duration to adequately explain the design intent and proper operating and maintenance techniques for all HVAC

equipment and systems. After these sessions are completed, the Contractor shall provide a copy of a signed statement by the Owner that his personnel are thoroughly familiar with and capable of operating all HVAC equipment and systems.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING AND BALANCING (TAB)

PART 1 - GENERAL

1.1 DESCRIPTION

A. Refer to specification section 23 00 00 - HVAC General, all of which applies to work described in this section as if written in full herein.

B. The work described by this section of the specifications consists of furnishing all materials, instruments, labor, and appurtenances to test, adjust and balance all of the HVAC systems furnished and installed under Division 23 of the specifications.

C. The TAB agency shall be a subcontractor of the General Contractor and shall not report to or be paid by the HVAC Contractor. The HVAC subcontractor shall be responsible to cooperate with and provide for the balancing subcontractor any and all materials, services, labor, etc. to facilitate completion of the balancing work.

1.2 QUALITY ASSURANCE

A. The TAB agency and its specialists shall be certified members of Associated Air Balance Council (AABC) or certified by the National Environmental Balance Bureau (NEBB) to perform TAB service for HVAC. The certification shall be maintained for the entire duration of duties specified herein. The TAB agency shall have been in business for at least the past five years and must be free of disciplinary action by either the AABC or the NEBB during that time.

B. All TAB technicians performing actual TAB work shall be experienced and must have done satisfactory work on a minimum of 3 projects comparable in size and complexity of this project and must be certified so by the TAB agency in writing.

C. The basic instrumentation shall be calibrated to accuracy requirements by its manufacturer, AABC or NEBB Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems. Submit calibration history of the instruments to be used for test and balance purpose during the preliminary and final submittal phase.

D. One or more of the applicable AABC, NEBB or SMACNA publications, supplemented by the ASHRAE Handbooks and requirements stated herein shall be the basis for planning, procedures, tolerances and reports. Final report shall cite the exact names of publications used as a basis or reference for the TAB work or reports.

1.3 DEFINITIONS

A. Retain definition(s) remaining after this Section has been edited.

B. AABC: Associated Air Balance Council.

C. NEBB: National Environmental Balancing Bureau.

D. TAB: Testing, adjusting, and balancing.

E. TABB: Testing, Adjusting, and Balancing Bureau.

F. TAB Specialist: An entity engaged to perform TAB Work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide plastic plugs to seal holes drilled in ductwork for test purposes.

B. Provide for repair of insulation removed or damaged for TAB work to match installation.

PART 3 - EXECUTION

3.1 TAB PROCEDURES

A. TAB shall be performed in accordance with the requirements of the Standard under which the TAB agency is certified, either AABC or NEBB.

B. During TAB all related system components shall be in full operation including Automatic Temperature Controls system. Fan and pump rotation, motor loads and equipment vibration shall be checked and corrected as necessary before proceeding with TAB. Set controls and/or block off parts of distribution systems to simulate design operation of variable volume air or water systems for test and balance work.

C. Adjustment of the temperature controls shall be coordinated by the TAB work specialist in conjunction with the Building Automation System/Automatic Temperature Control Company's Engineer. Both shall cooperate to simulate a complete cycle for every system in every mode of operation (automatic, economizer, fire emergency, etc.).

D. Coordinate TAB procedures with any phased construction completion requirements for the project. Provide TAB reports for each phase of the project prior to partial final inspections of each phase of the project.

E. Test and balance required in dwelling units must be completed and the TAB report submitted prior to occupancy. Coordinate with the general contractor, owner's representative, and mechanical subcontractor to schedule TAB well in advance of occupancy.

F. Record dates and time of day of all tests, and ambient conditions (dry bulb and wet bulb).

3.2 AIR SYSTEMS TAB

A. Systems shall be tested, adjusted and balanced so that air quantities and temperatures at outlets are as shown on the Contract Drawings and so that the distribution from supply outlets is uniform over the face of each outlet.

B. Direct reading velocity meters may be used for comparative adjustment of individual outlets, but air quantities in ducts having velocities of 1,000 feet per minute or greater shall be measured by means of pitot tubes and inclined gauge manometers. Instrument test opening enclosures shall be provided as required at the direction of the TAB agency.

C. Adjustments shall be made in such a manner that splitter and volume adjusters close to air outlets will have the least pressure drop consistent with volume requirements. Primary balancing shall be obtained by adjustment of the dampers at branch duct take-offs. Adjustable fan drives shall be used for making final adjustments of total air quantities. Additional dampers or other air volume adjusters required to accomplish the balancing and adjusting shall be furnished and installed as part of the HVAC work.

D. Artificially load air filters by partial blanking to produce air pressure drop of at least 90 percent of the design final pressure drop.

E. Check and readjust factory set minimum and maximum air terminal unit flow rates if necessary. Balance air distribution on full cooling maximum. Reset room thermostats and check operation from maximum to minimum cooling, to the heating mode, and back to cooling. Record and report the heating coil leaving air temperature when in the maximum heating mode.

F. Adjust fan speeds to provide design air flow. Adjust V-belt drives, including fixed pitch pulley requirements.

G. After completion of the testing, adjusting and balancing of the air systems, provide electronic files (e.g. PDFs, etc.) of the complete test report showing the minimum following information which shall be submitted to the Engineer for review:

1. Systems inspection narrative on equipment and installation for conformance with design
2. Duct Air Leakage Test Report
3. Systems Readiness Report
4. TAB report covering flow balance and adjustments, performance tests. Required information:
    a. Location of each air outlet or inlet. This shall be presented in the form of a reduced size floor plan showing outlet number keyed to the outlet number in the report.
    b. Dimensions or size of each outlet or inlet
    c. Type and manufacturer of diffusers, grilles, registers. Indicate duty as supply, return, exhaust, etc.
    d. CFM of air as indicated on the Drawings for each outlet or inlet with corresponding velocity
    e. Velocity of air as measured and corresponding cfm at which system has been balanced and adjusted, for each outlet or inlet
    f. Velocity of air measured and corresponding cfm, after each complete system has been balanced and adjusted, for each main branch or zone duct at the supply fan, the return fan and the exhaust fan, as the case may be
    g. After each complete system has been balanced and adjusted, the total cfm at fan discharge, the total return air to the apparatus, the total outside air to the apparatus, the total outside air to the apparatus, static pressure at fan outlet, total static pressure for apparatus, fan speed, motor amperage for each phase and voltage
5. Narrative of uncorrected installation deficiencies noted during TAB and applicable explanatory comments on test results that differ from design requirements.

H. The above testing, adjusting, and balancing shall be performed for the first season of the year, cooling season or heating season, which occurs at the completion of the building. Additional balancing and adjusting which may be required for the season of the year next following shall be performed as part of the work under this specification.

I. Ventilation air distribution systems (outdoor air and exhaust air) shall be balanced to achieve the airflow rates indicated on the drawings. These airflow rates shall be considered minimum rates. The measured air balance tolerance for both outdoor air and exhaust air rates shall be -0% to +10%.

J. For dwelling units, outdoor air and exhaust air shall be balanced/verified to achieve the airflow rates indicated on the drawings. Test and balance the air handling unit, including verifying/setting fan speed, and record cfm and static pressure in the test and balance report.

Ventilation air distribution systems (outdoor air and exhaust air) shall be balanced to achieve the airflow rates indicated on the drawings. These airflow rates shall be considered minimum rates. The measured air balance tolerance for supply air, outdoor air and exhaust air rates shall be -0% to +10%.

K. All parking garage mechanical ventilation systems shall be tested, adjusted, and balanced to provide air quantities indicated.

L. Dwelling unit outside air ventilation fans (OAF) shall have their fan speed adjusted to provide the outside air quantities scheduled. The controller shall be programmed per the manufacturer's installation instructions and the sequence of operation.

END OF SECTION

SECTION 23 07 00

HVAC INSULATION

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. All work specified herein shall be accomplished in accordance with the applicable requirements of Section 23 00 00 - HVAC General.

B. The insulation shall be installed in a neat and workmanlike manner by trained personnel regularly engaged in the installation of insulation and approved by the insulation manufacturer. Insulation, adhesives, coverings and coatings shall be applied in strict accordance with its respective manufacturer's recommendations. Installer has been in business for no less than 5 years and has completed at least 10 installations of similar size projects.

C. The contractor shall verify that test and inspection of the work to be insulated have been completed and approved before the insulation is applied.

D. All insulation must meet applicable codes for Flame Spread and Smoke Developed ratings when tested in accordance with ASTM 84 and UL 723.

1.2 WORK INCLUDED

A. The work done under this section shall include all labor, materials, accessories, services and equipment necessary to furnish and install all insulation, complete, as indicated on the Drawings and as specified herein.

1.3 QUALITY ASSURANCE

A. Materials shall be the standard products of manufacturers regularly engaged in the production of insulation products. Insulation materials shall be products that have been in use in commercial buildings for at least 2 years prior to bid opening.

B. Use of bubble wrap insulation is prohibited.

C. Insulations shall not contain asbestos, lead, mercury, mercury compounds, or polybrominated diphenyl ether fire retardants.

D. Insulation materials must meet service temperature and surface burning characteristics of NFPA 90A and 90B.

E. Surface Burning Characteristics:

1. Insulation shall have a composite insulation, jacket, binders, and adhesive Flame-Spread rating of 25 or less and a Smoke-Developed rating of 50 or less and shall be so listed by UL.
2. Insulation and related materials shall have surface burning characteristics determined by test performed on identical products per ASTM E 84, and UL 723, mounted and installed as per the North American Commercial and Industrial Insulation Standards (latest edition).
3. Adhesives, mastics, tapes, and other accessories shall have the same component ratings.
4. Materials shall be labeled indicating compliance with the above requirements.
5. All testing shall be performed by a testing and inspecting agency acceptable to authorities having jurisdiction. Insulation, jacket materials, adhesives, mastics, tapes and cement material containers shall be labeled with appropriate markings of applicable testing and inspecting agency.

1.4 RELATED WORK

A. Where pipes and ducts pass through fire walls, fire partitions, above grade floors, and fire rated chase walls, the penetration shall be protected and sealed with fire-stopping materials as specified in Section 23 00 00 - HVAC General.

B. Adequate provisions shall be made to protect the premises, equipment, and the work of other trades against droppings, adhesives and coatings used in the installation.

C. Where indicated, painting of insulation jackets shall be as specified in Section 09 91 00 - Painting.

D. Refer to Section 23 23 00 Refrigerant Piping, Insulation and Accessories for refrigerant piping insulation.

1.5 SUBMITTALS

A. Submit product information for insulation materials to the Architect in accordance with Division 1 and Section 23 00 00 - HVAC General.

B. Submit shop drawings and data to prove complete compliance with these specifications on products and methods of installation. Include materials used, thickness for each application, flame and smoke ratings, thermal conductivity, permeance, density for each product, and jackets (both factory and field applied). Indicate methods of applications.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide materials which are the standard products of manufacturers regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 3 years prior to purchase. Insulation shall be CFC and HCFC free.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Use of bubble wrap insulation is prohibited.

D. Provide insulation that meets or exceed the requirements of ASHRAE 90.1.

E. Insulation exterior shall be cleanable, grease resistant, non-flaking and non-peeling. Materials shall be compatible and shall not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either wet or dry state.

2.2 PIPE INSULATION FOR WATER PIPING

A. Materials as specified in this section shall be manufactured by Johns-Manville, Knauf, Manson Insulation, Dow Chemical, Owens-Corning or approved equal.

B. Insulation thicknesses shall be as shown in the following table:

Minimum Pipe Insulation			Insulation Thickness for Pipe Sizes					
Piping System Types	Fluid Operating Temperature Range		Mean Rating Temp.	Less than 1 in.	1 to less than 1-1/2 in.	1-1/2 to less than 4 in.	4 to less than 8 in.	8 in. and Larger
	°C	°F	°F	In.	In.	In.	In.	In.
(Cooling Systems)								
Condensate	4.4-15.6	40-60	75	0.5	1.0	1.0	1.0	1.5

C. Unless noted otherwise, the abovementioned piping systems inside the building shall be insulated with a 4 lb/ft^3 (nominal) density sectional fiberglass insulation with a thermal conductivity (k factor) not to exceed 0.23BTU·in/hr·ft^2·°F (0.033 W/m K), when tested in accordance with ASTM C 335 at 75 °F (24 °C). The jacket shall be fire retardant with a suitable vapor retarder. All joints and seams shall be sealed vapor tight. All joints and seams shall be lapped in place to form a continuous vapor retarder covering. All seams shall then be covered with “All Service Jacket” (ASJ) or ASJ+ 3" wide tape. The tape shall match the jacket. The tape shall be squeegeed in place to provide complete adhesion of the tape to the jacket and to provide a continuous vapor retarder covering. Exterior water piping shall be heat traced (Refer to Section 23 21 13 - PIPING AND ACCESSORIES).

D. Piping installed outdoors shall be insulated with cellular glass insulation, Owens-Corning “Foamglas” or approved equal. Insulation thickness required to prevent condensation shall be determined by the manufacturer for worse case ambient conditions.

1. Install with all service jacket and in accordance with manufacturer’s recommendations.
2. Where heat tracing is specified, oversize insulation to allow space for heat tape.

E. Provide high compressive strength preformed pipe insulation inserts at all pipe hangers. Inserts shall be equal to Foamglas by Owens-Corning or calcium silicate. Calcium silicate is not to be used on systems operating below 80F. Provide ribbed hanger saddles by Centerline, Buckaroos, Inc. or approved equal.

F. All exposed insulated piping in mechanical rooms below 10'-0" AFF shall be protected by a corrugated aluminum jacket with bands 1'-0" on center.

2.4 BLANKET TYPE INSULATION (DUCTWRAP)

A. Description:

1. Flexible, limited combustible, blanket type insulation composed of mineral or inorganic glass fibers bonded together with a thermosetting resin, meeting ASTM C 553, Type 1 and ASTM C 1290.
2. Vapor retarder jacket: Provide one of the following types of vapor retarder jackets:
   a. Foil-scrim-kraft (FSK), foil reinforced kraft (FRK), or polypropylene-scrim-kraft (PSK) with a 2" (50mm) (min.) stapling and taping flange on one edge.
   b. Conforming to ASTM C 1136 Type II.
3. Surface Temperature Application Limits: Insulation shall be rated for use on surfaces operating at temperatures up to 250°F.
4. Ratings:

Insulation Type:	Type 1:	Type 2:
Minimum R-Value, out of package*: hr•ft²•°F/Btu (m²•°C/W) at 75°F (24°C) mean temperature	R-7.4 (1.30)	R-15.0 (2.66)
Minimum R-Value, installed: hr•ft²•°F/Btu (m²•°C/W) at 75°F (24°C) mean temperature	R-6.0 (1.06)	R-12.0 (2.16)
Minimum Density: lb/ft³ (kg/m³)	1.0 (16)	0.75 (12)
Thickness: Inches (mm)	2 (51)	4 2/5 (112)
Maximum Labeled K-value at 75°F (24°C) mean temperature: Btu.•in/hr.•ft²•°F (W/m.•°C)	0.27 (0.039)	0.29 (0.042)

*Value may vary by manufacturer; minimum installed value must be met

B. Insulate the following with Type 1 blanket insulation:

1. All galvanized steel ductwork containing heated and/or cooled supply air, except:
   a. Exposed ductwork in finished conditioned spaces.
   b. Ductwork indicated to be internally lined or insulated with external insulation.
2. Concealed surfaces of ceiling diffusers exposed to non-return air plenums.
3. Return air ductwork exposed to attics or non-return air plenums.
4. Relief air ductwork and plenums from the exterior to 18” past the relief air damper assembly.
5. Return air, toilet exhaust, and general exhaust ductwork exhausting conditioned air and routed through interior spaces that are ventilated with outside air or exposed to outside air conditions.
6. Concealed outside air ductwork located within indirectly conditioned spaces (e.g. indoor soffits, furr-downs, vertical chases, etc.).
7. Ductwork and plenums located inside of the building (i.e. located within the exterior boundary or skin of the building thermal envelope) when containing or flowing, makeup air, garage ventilation intake or exhaust air ducts and plenums, when not indicated to be insulated with rigid fiberglass insulation. This applies to ducts and plenums whether exposed or concealed within chases when located on the interior side of the exterior skin of heated or cooled space.

C. Insulate the following with Type 2 blanket insulation:

1. Ductwork and plenums located outside of the exterior boundary or skin of the building thermal envelope when containing or flowing heated and/or cooled air when not indicated to be insulated with rigid fiberglass insulation.
2. Supply air ductwork located in unconditioned attic spaces and in indoor spaces that are ventilated with outside air or exposed to outside air conditions.
3. Concealed surfaces of ceiling diffusers exposed to attics.

D. Subject to compliance with requirements, insulation shall be manufactured by: CertainTeed, Johns Manville, Knauf, Owens-Corning, Manson Industries, or approved equal.

2.5 DUCT LINER

A. Refer to Section 23 31 00 – Ductwork and Accessories for duct liner requirements.

2.6 EXTERIOR SUPPLY AND RETURN AIR DUCTWORK

A. Exterior supply and return air ductwork shall be constructed of galvanized sheet metal lined with 2" thick 3 lb/ft^3 duct liner board (R-12 min.); Johns-Manville Linacoustic R-300. All ductwork seams shall be externally sealed watertight with a 30-year silicone caulk and coated with a rust preventive coating over the entire duct surface.

1. As an alternative to insulated sheet metal, an outdoor duct system as manufactured by Thermaduct, LLC may be used. The system shall incorporate duct and fittings having an installed minimum R-value of 12. The system shall utilize non-fibrous closed cell Kingspan KoolDuct fortified inner liner compliant to UL (C-UL) 181, Standard for Safety Listed, Class 1 system and SMACNA Class 1 leakage, or less. Submit product data and layout drawings during the submittal phase.
2. As an alternative to internal insulation, exterior insulation may be Class B foil faced polyisocyanurate foam insulation with weather resistant white flexible cladding; Alumaguard Lite White by Polyguard. Install in accordance with manufacturer's installation instructions.
3. As an alternative to internal insulation, exterior insulation may be physically crosslinked closed cell polyolefin foam insulation with factory applied heavy duty multilayer composite foil facing with a UV and weather durable coating; Thermobreak No-Clad insulation by Sekisui Voltek. Install in accordance with manufacturer's installation instructions.

2.7 DUCTWORK WITHIN MECHANICAL ROOMS

A. Ducts within mechanical rooms shall be insulated with 1½" thick, 3 lb/ft^3 rigid fiberglass board with an R factor of not less than 6 (K = 0.23 at 75 degrees F mean temperature) with reinforced foil vapor retarder. Insulation shall be secured to ductwork with stick pins and speed washers. All joints and stick pin terminations shall be sealed with 3" wide strips of vapor retarder material and applied to form a continuous vapor seal.

B. Apply 1" x 1" x 30 mils thick white PVC corner angles in accordance with ASTM D 1784, Class 16354-C at all insulation board corners.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Shop drawing submittals shall include a complete package of materials and methods intended for use as described in this section.

B. All work shall be in strict accordance with applicable codes, ordinances and the manufacturer's recommendations. Install all mechanical insulation materials and accessories in accordance with manufacturer's published instructions (latest edition) and industry practices detailed by the North American Commercial and Industrial Insulation Standards Manual (latest edition).

C. All work shall be performed in a professional workmanlike manner and standard trade practice. It shall be smooth in appearance and suitable for finish painting.

D. All exterior piping shall be installed with a corrugated aluminum jacket with bands 1'-0" on center.

E. Fiberglass pipe insulation shall be applied to clean (free of rust) dry pipe prior to leak testing. Chilled and condenser water systems shall not be operated until the insulation is completely installed with a vapor retarder in place. Refer to Section 23 21 13 - Piping and Accessories for additional information.

END OF SECTION

SECTION 23 08 00

COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section.

B. The OPR and BOD documentation are included by reference for information only.

C. Division 01 section “Sustainable Design Requirements” for additional NGBS requirements.

1.2 SUMMARY

A. This section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.

B. Related Sections:

1. Division 01 Section “General Commissioning Requirements” for general commissioning process requirements.

1.3 DESCRIPTION

A. Refer to Division 01 Section “General Commissioning Requirements” for the description of commissioning.

1.4 DEFINITIONS

A. Refer to Division 01 Section “General Commissioning Requirements” for definitions.

1.5 SUBMITTALS

A. Refer to Division 01 Section “General Commissioning Requirements” for CxA’s role.

B. Refer to Division 01 Section “Submittals” for specific requirements.

C. In addition, provide the following:

1. Certificates of readiness
2. Certificates of completion of installation, prestart, and startup activities.
3. O&M manuals
4. Test reports

1.6 QUALITY ASSURANCE

A. Test Equipment Calibration Requirements: Contractors will comply with test manufacturer’s calibration procedures and intervals. Recalibrate test instruments immediately after instruments have been repaired resulting from being dropped or damaged. Affix calibration tags to test instruments. Furnish calibration records to CxA upon request.

1.7 COORDINATION

A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to coordination during the commissioning process.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. All standard testing equipment required to perform startup, initial checkout and functional performance testing shall be provided by the Contractor for the equipment being tested. For example, the mechanical contractor of Division 23 shall ultimately be responsible for all standard testing equipment for the HVAC&R system and controls system in Division 23, except for equipment specific to and used by TAB in their commissioning responsibilities. A sufficient quantity of two-way radios shall be provided by each subcontractor.

B. Special equipment, tools and instruments (specific to a piece of equipment and only available from vendor) required for testing shall be included in the base bid price to the Owner and left on site.

C. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the Owner upon completion of the commissioning process.

D. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5°F and a resolution of + or - 0.1°F. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.

PART 3 - EXECUTION

3.1 GENERAL DOCUMENTATION REQUIREMENTS

A. With assistance from the installing contractors, the CxA will prepare Pre-Functional Checklists for all commissioned components, equipment, and systems.

B. **Operation and Maintenance Data:**

1. Contractor will provide a copy of O&M literature within 45 days of each submittal acceptance for use during the commissioning process for all commissioned equipment and systems.
2. The CxA will review the O&M literature once for conformance to project requirements.
3. The CxA will receive a copy of the final approved O&M literature once corrections have been made by the Contractor.

C. **Demonstration and Training:**

1. Contractor will provide demonstration and training as required by the specifications.
2. A training agenda for each training session must be submitted to the CxA one (1) week prior the training session.
3. The CxA shall be notified at least 72 hours in advance of scheduled tests. A copy of the test record shall be provided to the CxA, Owner, and Architect.
4. Engage a Factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specific equipment.

5. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, trouble shooting, servicing, and maintaining equipment.
6. Review data in O&M Manuals.

3.2 CONTRACTOR'S RESPONSIBILITIES

A. Mechanical, Controls and TAB Contractors. The commissioning responsibilities applicable to each of the mechanical, controls and TAB contractors of Division 23 are as follows (all references apply to commissioned equipment only):

B. Perform commissioning tests at the direction of the CxA.

C. Attend construction phase controls coordination meetings.

D. Attend testing, adjusting, and balancing review and coordination meetings.

E. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

F. Provide information requested by the CxA for final commissioning documentation.

G. Include requirements for submittal data, operation and maintenance data, and training in each purchase order or sub-contract written.

H. Prepare preliminary schedule for Mechanical system orientations and inspections, operation and maintenance manual submissions, training sessions, pipe and duct system testing, equipment start-up, testing and balancing and task completion for owner. Distribute preliminary schedule to commissioning team members.

I. Update schedule as required throughout the construction period.

J. During the startup and initial checkout process, execute the related portions of the prefunctional checklists for all commissioned equipment.

K. Provide measuring instruments and logging devices to record test data and provide data acquisition equipment to record data for the complete range of testing for the required test period.

L. Gather operation and maintenance literature on all equipment and assemble in binders as required by the specifications. Submit to CxA (45) days after submittal acceptance.

M. Notify the CxA a minimum of two (2) weeks in advance of the time for start of the testing and balancing work. Attend the initial testing and balancing meeting for review of the official testing and balancing procedures.

N. Participate in, and schedule vendors and contractors to participate in the training sessions.

O. Provide written notification to the CM/GC and CxA Authority that the following work has been completed in accordance with the contract documents, and that the equipment, systems, and sub-system are operating as required.

1. HVAC&R equipment including all fans, air handling units, ductwork, dampers, fan coil units, and all other equipment furnished under this Division.

P. The equipment supplier shall document the performance of his equipment.

Q. Test, Adjust and Balance Contractor

1. Attend initial commissioning coordination meeting scheduled by the Commissioning Authority.
2. Attend the testing and balancing review meeting scheduled by the CxA. Be prepared to discuss the procedures that shall be followed in testing, adjusting, and balancing the HVAC&R system.
3. At the completion of the testing and balancing work, and the submittal of the final testing and balancing report, notify the HVAC&R contractor and the CM/GC.

R. Provide training of the Owner's operating staff using expert qualified personnel, as specified.

S. Equipment Suppliers

1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner, to keep warranties in force.
2. Assist in equipment testing per agreements with contractors.
3. Provide information requested by CxA regarding equipment sequence of operation and testing procedures.

T. Refer to Division 01 Section "General Commissioning Requirements" for additional contractor responsibilities.

3.3 OWNER'S RESPONSIBILITIES

A. Refer to Division 01 Section "General Commissioning Requirements" for Owner's responsibilities.

3.4 DESIGN PROFESSIONAL'S RESPONSIBILITIES

A. Refer to Division 01 Section "General Commissioning Requirements" for Design Professional's responsibilities.

3.5 CxA'S RESPONSIBILITIES

A. Refer to Division 01 Section "General Commissioning Requirements" for CxA's responsibilities.

3.6 TESTING PREPARATION

A. Certify in writing to the CxA that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify in writing to the CxA that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Certify in writing that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.

D. Place systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Inspect and verify the position of each device and interlock identified on checklists.

F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.7 TESTING, ADJUSTING AND BALANCING

A. Prior to performance of Testing, Adjusting and Balancing work, provide copies of reports, sample forms, checklists, and certificates to the CxA.

B. Notify the CxA a minimum of two (2) weeks in advance of testing and balancing Work.

3.8 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.

C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

D. The CxA along with the HVAC&R contractor, Testing and Balancing Subcontractor, and HVAC&R Instrumentation and Control Subcontractor shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

G. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

H. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

3.9 HVAC&R SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. **Equipment Testing and Acceptance Procedures**: Testing requirements are specified in individual Division 23 sections. Provide submittals, test data, inspector record, and certifications to the CxA.

B. **Refrigeration System Testing:** Provide technicians, instrumentation, tools, and equipment to test performance of chillers, refrigerant compressors and condensers, heat pumps, and other refrigeration systems. The CxA with input from the HVAC contactor and CM/GC shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

C. **HVAC&R Distribution System Testing**: Provide technicians, instrumentation, tools, and equipment to test performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.

D. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of all components, systems and sub-systems. The following equipment and systems shall be evaluated:

1. Refer to Commissioning Plan for scope of work.

3.10 DEFICIENCIES/NON-CONFORMANCE, COST OF RETESTING, FAILURE DUE TO MANUFACTURER DEFECT

A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to deficiencies/non-conformance, cost of retesting, or failure due to manufacturer defect.

3.11 APPROVAL

A. Refer to Division 01 Section “General Commissioning Requirements” for approval procedures.

3.12 DEFERRED TESTING

A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to deferred testing.

3.13 OPERATION AND MAINTENANCE MANUALS

A. The Operation and Maintenance Manuals shall conform to Contract Documents requirements as stated in Division 01.

B. Refer to Division 01 Section “General Commissioning Requirements” for the AE and CxA roles in the Operation and Maintenance Manual contribution, review and approval process.

C. An updated as-built version of the control drawings and sequences of operation shall be included in the final controls O&M manual submittal.

3.14 TRAINING OF OWNER PERSONNEL

A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to training.

B. **Mechanical Contractor.** The mechanical contractor shall have the following training responsibilities:

1. Provide the CxA with a training plan two (2) weeks before the planned training.
2. Provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of HVAC equipment including, but not limited to, all HVAC equipment (ex. pumps, chillers, heat rejection equipment, air conditioning units, air handling units, fans, etc.)
3. Training shall normally start with classroom sessions followed by hands-on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.

4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary, and the demonstration repeated.
5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment are required. More than one party may be required to execute the training.
6. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
7. Training shall include:
    a. Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.
    b. A review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.
    c. Discussion of relevant health and safety issues and concerns.
    d. Discussion of warranties and guarantees.
    e. Common troubleshooting problems and solutions.
    f. Explanatory information included in the O&M manuals and the location of all plans and manuals in the facility.
    g. Discussion of any peculiarities of equipment installation or operation.
    h. The format and training agenda in The HVAC Commissioning Process, ASHRAE Guideline 1-2007, is recommended.
8. Hands-on training shall include start-up, operation in all modes possible, including manual, shutdown and any emergency procedures and preventative maintenance for all pieces of equipment.
9. The mechanical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.
10. Training shall occur after functional testing is complete, unless approved otherwise by the Owner.

C. **TAB.** The TAB contractor shall have the following training responsibilities:

1. TAB shall meet for with facility staff after completion of TAB and instruct them on the following:
    a. Go over the final TAB report, explaining the layout and meanings of each data type.
    b. Discuss any outstanding deficient items in control, ducting or design that may affect the proper delivery of air or water.
    c. Identify and discuss any duct runs, diffusers, coils, fans and pumps that are close to or are not meeting their design capacity.
    d. Discuss any temporary settings and steps to finalize them for any areas that are not finished.
    e. Other salient information that may be useful for facility operations, relative to TAB.

END OF SECTION

SECTION 23 09 00

AUTOMATIC CONTROLS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. All work specified herein shall be accomplished in accordance with the applicable requirements of Section 23 00 00 - HVAC General.

B. Furnish and install a complete system of automatic controls of the type and characteristics and which will perform the functions described herein and on the Drawings.

C. All equipment, labor, tubing, etc. required to accomplish the control sequences outlined in this section shall be furnished as part of the HVAC work.

D. All other HVAC equipment purchased and installed as described in other sections of these specifications shall be coordinated with the requirements of this section to assure compatibility and function.

E. All electrical control wiring required as part of this work shall be furnished and installed as part of the HVAC work and shall be installed in accordance with Division 26.

F. This section generally describes the desired operating sequence and characteristics of all HVAC systems provided and installed as part of Division 23 of these specifications. The preparation of the detailed control schematics necessary to accomplish the desired systems operation shall be included as part of the HVAC work. Electronic files (e.g. PDFs, etc.) of these control schematics shall be submitted and reviewed by the Engineer as part of the Submittal Phase and prior to the purchase or installation of any control equipment or other equipment that depends on these control schemes for proper operation.

G. Mount top of thermostats and sensors at 46" AFF unless noted otherwise. Provide clear locking guard assemblies for all public area thermostats. Coordinate thermostat locations with all trades. Coordinate final locations with the general contractor, interior designer and the owner prior to installation. Locate adjacent to light switches where possible. Do not locate thermostats at the center or near center of a wall. Thermostats shall be mounted no closer than 8" from the corner or end of a wall or door. All thermostats shall be ADA compliant.

H. All major control equipment shall be located in a suitable enclosure in the Mechanical Room.

I. Mechanical, Electrical, Plumbing, and other controls shall not be installed in ductwork or through dampers.

1.2 CODES AND REFERENCES

A. National Fire Protection Association – 70, 90A, 90B, 92

B. ASHRAE Standards and Guidelines

1.3 SUBMITTALS

A. Product Requirements: Provide electronic copies (or PDF) of shop drawings and other submittals on hardware, software, and equipment to be installed or furnished. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and

startup instructions for each type of product indicated. Begin no work until submittals have been approved for conformity with design intent. When manufacturer's cut sheets apply to a product series rather than a specific product, clearly indicate applicable data by highlighting or by other means. Clearly reference covered specification and drawing on each submittal. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements. Select and show submittal quantities appropriate to scope of work. Submittal approval does not relieve Contractor of responsibility to supply sufficient quantities to complete work. Provide submittals on the following:

1. Wiring diagrams and layouts for each control panel. Show termination numbers.
2. Manufacturer's description and technical data such as performance curves, product specifications, and installation and maintenance instructions for items listed and for relevant items not listed: Control panels, Thermostats, sensors, and Operator interface equipment.
3. Operation and Maintenance (O&M) Manuals

1.4 MANUFACTURERS

A. Acceptable manufacturers/installers for automatic controls: Johnson Controls, Siemens, Automated Logic, Honeywell, American Auto-Matrix, Alerton, Distech Controls, Delta, Schneider Electric, Carrier, or Trane.

PART 2 - PRODUCTS

2.1 GENERAL

A. Only those products of particular importance to appearance or function are described in this Products section. Other items required for satisfactory systems operation but not herein described shall be furnished and installed to meet the intent and Operating Sequences herein described.

2.2 AUTOMATIC CONTROL DAMPERS

A. Dampers shall be AMCA rated and certified.

B. Dampers shall be of the opposed blade low leakage type with polyurethane blade seals and stainless-steel jamb seals.

C. Leakage shall not exceed 1% of full air flow at 4" WG and below (based on 1,500 FPM approach velocity).

D. Units shall be full size of ductwork with duct mounting flanges as shown on the Drawings.

E. Dampers shall be manufactured by Ruskin, Greenheck, Johnson Controls, or equal with required operators.

2.3 AUTOMATIC SHUTDOWN OF RECIRCULATING AIR SYSTEMS

A. All fans supplying more than 2,000 cfm of air to any space shall be installed with a smoke detector in the return ductwork. Duct smoke detectors shall be installed in the return air path of air distribution systems utilizing a common supply and/or return air plenum with a combined design capacity greater than 2,000 cfm.

B. The smoke detector shall be wired to stop the fan upon detection of smoke and signal the building fire alarm control panel. The smoke detector shall be furnished by the Electrical Contractor, mounted in the duct by the HVAC Contractor, and wired by the Electrical Contractor.

2.4 DAMPER ACTUATORS FOR LIFE SAFETY SYSTEMS

A. Actuators shall be powered closed, and spring operated to fail open upon loss of power.

PART 3 - EXECUTION

3.1 SEALING PENETRATIONS

A. All penetrations in walls, ceilings, and partitions required by controls work shall be sealed with an appropriate pliable sealant or fire caulking to make the penetration airtight and maintain the integrity of the fire rating. Penetrating items shall include, but not be limited to, conduit, cables, control wiring (especially for thermostats and sensors), hangers, mounting hardware, etc.

3.2 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls.

B. Provide at least two persons equipped with two-way communication. Demonstrate calibration and response of any input and output points requested by the Engineer and/or the Commissioning Agent (Cx). Provide and operate test equipment required to prove proper system operation. Demonstrations shall be performed in the presence of the Engineer, Cx, and owner simultaneously.

C. Demonstrate compliance with sequences of operation through each operational mode.

D. Demonstrate complete operation of operator interface.

E. Demonstrate: DDC Loop Response, Demand Limiting, Building Fire Alarm System Interface, and Trend Logs for each system.

F. Tests that fail to demonstrate proper system operation shall be repeated after Contractor makes necessary repairs or revisions to hardware or software to successfully complete each test.

G. Acceptance

1. After tests described in this specification are performed to the satisfaction of the Engineer, Cx, and Owner, the Engineer will accept the control system as meeting completion requirements. Engineer may exempt tests from completion requirements that cannot be performed due to circumstances beyond Contractor's control. Engineer will provide written statement of each exempted test. Exempted tests shall be performed as part of warranty.
2. System shall not be accepted until completed demonstration forms and checklists are submitted and approved as required in paragraph 1.03 (Submittals).

3.3 OPERATING SEQUENCE

A. All units and systems shall be controlled as described on the Drawings and as recommended by equipment manufacturers.

END OF SECTION

SECTION 23 09 20

VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 DESCRIPTION

A. All work specified herein shall be accomplished in accordance with the applicable requirements of Section 23 00 00 - HVAC General.

B. This specification is to cover a complete variable frequency motor drive (VFD) consisting of a pulse width modulated (PWM) inverter for use on a standard NEMA Design B induction motor.

1.2 QUALITY ASSURANCE

A. Referenced Standards

1. Institute of Electrical and Electronic Engineers (IEEE)
2. Standard 519-Latest Edition, IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems
3. Underwriters Laboratories Inc.
    a. UL 508C
4. National Electrical Manufacturer's Association (NEMA)
    a. ISC 6, Enclosures for Industrial Controls and Systems
    b. ISC 7.0, AC Adjustable
5. IEC 16800 Parts 1 and 2

B. Qualifications

1. VFDs shall be UL Listed.
2. VFDs shall be CUL Listed or CSA Approved.

C. VFD shall be manufactured in an ISO 9002 certified facility.

D. VFD shall be manufactured in accordance with ISO 14001 (Environmental Management Standard).

E. VFD shall meet the following vibration test standards: IEC 60068-2-29; 60068-2-64; 60068-2-6.

1.3 SUBMITTALS

A. Submittals shall include the following information:
1. Outline dimensions
2. Weight

1.4 WARRANTY

A. Warranty shall be 24 months from the date of certified start-up, not to exceed 30 months from the date of shipment. The warranty shall include all parts, labor, travel time, and expenses.

PART 2 - PRODUCTS

2.1 ADJUSTABLE FREQUENCY DRIVES

SECTION 23 09 20

VARIABLE FREQUENCY DRIVES

A. Manufacturers

1. Drives and all necessary controls, as herein specified shall be supplied by the drive manufacturer. Manufacturer shall have been engaged in the production of this type of equipment for a minimum of ten (10) years.
2. All drives on the project shall be by the same manufacturer.
3. Acceptable Manufacturers shall be ABB, Emerson, Danfoss, Yaskawa, Siemens, Eaton or Square D.

B. General

1. Drives shall be designed specifically for variable torque applications.
2. The adjustable frequency drives shall be solid state, with a Pulse Width Modulated (PWM) output waveform.
3. The VFD package as specified herein shall be enclosed in a NEMA 1 enclosure (unless located outdoors; a NEMA 3R enclosure shall be furnished), completely assembled and tested by the manufacturer. The VFD shall employ a full wave rectifier (to prevent input line notching), DC Line Reactor, capacitors, and Insulated Gate Bipolar Transistors (IGBTs) as the output switching device, or the VFD shall consist of Matrix technology, where the input power stage converts three phase AC line power directly into variable AC output. The Main circuit shall consist of a compact input filter and bidirectional IGBT's. The bidirectional switches are input devices that carry the full current of the drive.
4. The drive efficiency shall be 97% or better at full speed and full load. Fundamental power factor shall be 0.98 at all speeds and loads.

C. Specifications for the 1 HP to 400 HP (550 HP w/o bypass) VFD at 480 Volts and 1 to 100 HP VFD at 230 Volts:

1. Input 440/460/480/500 VAC +/-10% (capable of operation to 624 VAC), 3-phase, 48 - 63 Hz or Input 208/220/230/240 VAC +/-10%, 3-phase, 48 - 63 Hz.
2. Output 0 - Input Voltage, 3-phase, 0 to 500 Hz for drives up to 75 HP; 0 to 120 Hz for drives over 75 HP. Operation above 60 Hz. shall require programming changes to prevent inadvertent high-speed operation.
3. Environmental operating conditions: 14 to 120°F (-10 to 50° C) @ 3 kHz switching frequency, 0 to 3,300 feet above sea level, less than 95% humidity, non-condensing.
4. Enclosure shall be rated UL Type 1.

D. All VFDs shall have the following standard features:

1. All VFDs shall have the same customer interface, including digital display, keypad and customer connections regardless of horsepower rating. The keypad is to be used for local control, for setting all parameters, and for stepping through the displays and menus.
2. The VFD shall give the user the option of either 1) displaying a fault, 2) running at a programmable preset speed, 3) hold the VFD speed based on the last reference received, or 4) cause a Warning to be issued, if the input reference (4-20mA or 2-10V) is lost as selected by the user. The VFD shall provide a programmable relay output for customer use to indicate the loss of reference condition.
3. The VFDs shall utilize plain English digital display (code numbers and letters are not acceptable). The LCD shall be backlit to provide easy viewing in any light condition. The contrast should be adjustable to optimize viewing at any angle. All set-up parameters,

indications, faults, warnings and other information must be displayed in words to allow the user to understand what is being displayed without the use of a manual or cross-reference table. Keypad shall have a built-in time clock capable of month, day and time stamping faults.

4. The VFDs shall utilize pre-programmed application macros specifically designed to facilitate start-up. The Application Macros shall provide one command to reprogram all parameters and customer interfaces for a particular application to reduce programming time.
5. The VFD shall have the ability to automatically restart after an overcurrent, overvoltage, under voltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between reset attempts shall be programmable. If the time between reset attempts is greater than zero, the time remaining until reset occurs shall count down on the display to warn an operator that a restart will occur.
6. The VFD shall be capable of starting into a rotating load (forward or reverse) and accelerate or decelerate to setpoint without safety tripping or component damage (flying start).
7. The VFD shall be equipped with an automatic extended power loss ride-through circuit which will utilize the inertia of the load to keep the drive powered. Minimum power loss ride-through shall be one-cycle, based on full load and no inertia. Removing power from the motor is not an acceptable method of increasing power loss ride-through.
8. The customer terminal strip shall be isolated from the line and ground.
9. Pre-wired 3-position Hand-Off-Auto switch and speed potentiometer. When in "Hand," the VFD will be started, and the speed will be controlled from the speed potentiometer. When in "Off," the VFD will be stopped. When in "Auto," the VFD will start via an external contact closure, and its speed will be controlled via an external speed reference.
10. The drive shall employ the following 3 current limit circuits to provide trip free operation:
    a. The Slow Current Regulation limit circuit shall be adjustable to 130% (minimum) of the VFDs variable torque current rating. This adjustment shall be made via the keypad, and shall be displayed in actual amps, and not as percent of full load.
    b. The Rapid Current Regulation limit shall be adjustable to 170% (minimum) of the VFDs variable torque current rating.
    c. The Current Switch-off limit shall be fixed at 175% (minimum, instantaneous) of the VFDs variable torque current rating.
11. The overload rating of the drive shall be 110% of its variable torque current rating for 1 minute every 10 minutes, and 130% of its variable torque current rating for 2 seconds every 60 seconds.
12. The VFD shall have input line fuses or circuit breakers standard in the drive enclosure.
13. The VFD shall have a DC Line Reactor to reduce the harmonics to the power line and to increase the fundamental power factor. Dual DC link chokes may be utilized as an acceptable alternate.
14. The VFD shall be optimized for a 4 kHz carrier frequency to reduce motor noise and provide high system efficiency. Carrier frequency shall be selectable for 1, 2, 4, 8, 10, or 12 kHz.
15. The VFD shall include a fireman's override input. This mode shall override all other control modes (analog, digital, serial and keypad commands) and the motor shall run at the preprogrammed speed. The keypad shall display "Override Mode" status. Upon removal of the override signal, normal operation shall be resumed.

E. All VFDs shall have the following adjustments:

1. Three (3) programmable critical frequency lockout ranges to prevent the VFD from continuously operating at an unstable speed.
2. PI Setpoint controller shall be standard in the drive, allowing a pressure or flow signal to be connected to the VFD, using the microprocessor in the VFD for the closed loop control.

3. Two (2) programmable analog inputs shall accept a current or voltage signal for speed reference or for reference and actual (feedback) signals for PI controller. Analog inputs shall include a filter; programmable from 0.01 to 10 seconds to remove any oscillation in the input signal. The minimum and maximum values (gain and offset) shall be adjustable within the range of 0 - 20 mA and 0 - 10 Volts. Additionally, the reference must be able to be scaled so that maximum reference can represent a frequency less than 60 Hz, without lowering the drive maximum frequency below 60 Hz.
4. Six (6) programmable digital inputs for maximum flexibility in interfacing with external devices. One (1) digital input is to be utilized as a customer safety connection point for fire, freeze, and smoke interlocks (Enable). Upon remote, customer reset (reclosure of interlock), drive is to resume normal operation.
5. Two (2) programmable analog outputs proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, or Active Reference.
6. Three (3) programmable digital relay outputs. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 amps at 250 VAC; Maximum voltage 300 VDC and 250 VAC; Continuous current rating 2 amps RMS. Outputs must be true form C type contacts; open collector outputs are not acceptable.
7. Seven (7) programmable preset speeds.
8. Two (2) independently adjustable accel and decel ramps. These ramp times shall be adjustable from 1 to 1,800 seconds.
9. The VFD shall Ramp or Coast to a stop, as selected by the user.

F. The following operating information displays shall be standard on the VFD digital display. The display shall be in complete English words (alpha-numeric codes are not acceptable).

1. Output Frequency
2. Motor Speed (RPM, % or Engineering units)
3. Motor Current
4. Calculated Motor Torque
5. Calculated Motor Power
6. DC Bus Voltage
7. Output Voltage
8. Heatsink Temperature
9. Analog Input Values
10. Keypad Reference Values
11. Elapsed Time Meter
12. kWh meter

G. The VFD shall have the following protection circuits. In the case of a protective trip, the drive shall stop, and announce the fault condition in complete words (alpha-numeric codes are not acceptable).

1. Overcurrent trip 175% instantaneous of the VFDs variable torque current rating.
2. Overvoltage trip 130% of the VFDs rated voltage
3. Under voltage trip 65% of the VFDs rated voltage
4. Over temperature +176-194^{o}F (+80-90^{o}C)
5. Ground Fault either running or at start
6. Adaptable Electronic Motor Overload (I2t). The Electronic Motor Overload protection shall protect the motor based on speed, load curve, and external fan parameter. Circuits which are not speed dependent are unacceptable. The electronic motor overload protection shall be UL Listed for this function.

H. Speed Command Input shall be via:

1. Keypad.
2. Two (2) analog inputs, each capable of accepting a 0-20mA, 4-20mA, 0-10V, 2-10V signal. Input shall be isolated from ground, and programmable via the keypad for different uses.
3. Analog inputs shall have a programmable filter to remove any oscillation of the reference signal. The filter shall be adjustable from 0.01 to 10 seconds. The analog input should be able to be inverted, so that minimum reference corresponds to maximum speed, and maximum reference corresponds to minimum speed. The minimum and maximum values (gain and offset) shall be adjustable within the range of 0 - 20 mA and 0 - 10 Volts. The active analog input shall have loss of reference protection, if selected.
4. Floating point input shall accept a 3-wire input from a Dwyer Photohelic (or equivalent type) instrument.

I. Serial Communications

1. The VFD shall have embedded Modbus RTU, BACnet, Siemens FLN and Johnson Metasys N2 protocols as standard for building automation systems network communications accessible via a RS-485 port.
2. Optional protocols shall include LonWorks, and Ethernet.
3. The VFD shall be able to communicate with PLCs, DCSs, and DDCs.
4. Serial communication capabilities shall include, but not be limited to, run-stop control, speed set adjustment, proportional/integral PI controller adjustments, current limit, and accel/decel time adjustments. The drive shall have the capability of allowing the Building Automation System (BAS) to monitor feedback such as output speed/frequency, current (in amps), % torque, % power, kilowatt hours, relay outputs, and diagnostic fault information.

J. Accessories to be Furnished and Mounted by the Drive Manufacturer

1. Customer Interlock Terminal Strip - provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external interlocks and start/stop contacts shall remain fully functional whether the drive is in Hand, Auto or Bypass.
2. All wires to be individually numbered at both ends for ease of troubleshooting.
3. Door interlocked thermal magnetic circuit breaker which will disconnect all input power from the drive and all internally mounted options. The disconnect handle shall be thru-the-door type and be padlockable in the “Off” position.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be the responsibility of the mechanical contractor. The contractor shall install the drive-in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.

B. The manufacturer must ensure that the installed THD is less than 5%. Should the voltage THD exceed 5%, the VFD manufacturer is to recommend the additional equipment required to reduce the voltage THD to an acceptable level.

C. Power wiring shall be completed by the electrical contractor. The contractor shall complete all wiring in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.

1. VFD rated shielded cabling shall be provided between the drive and the motor.

D. When 6 pulse drives are used, provide dv/dt filters when the VFD is between 100 and 300 feet from the motor and provide sine wave filters when the VFD is over 300 feet from the motor.

3.2 START-UP

A. Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the Owner, and a copy kept on file at the manufacturer.

3.3 TRAINING

A. The manufacturer shall provide on-site training for the Owner's maintenance personnel for a period of not less than four (4) hours. Training shall be provided for each different type of drive.

END OF SECTION

SECTION 23 23 00

REFRIGERANT PIPING, INSULATION AND ACCESSORIES

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. All work specified herein shall be accomplished in accordance with the applicable requirements of Section 23 00 00 - HVAC General.

B. Refrigerant piping shall meet the requirements of the Safety Standard for Refrigeration Systems (ANSI/ASHRAE Standard 15-Latest Edition) and the Code for Pressure Piping (ANSI/ASME Standard B31.5-Latest Edition: Refrigeration Piping and Heat Transfer Components).

C. Piping, valves, accessories, and insulation installed indoors shall have a flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.2 WORK INCLUDED

A. The work under this section shall include all labor, materials, accessories, services, and equipment necessary to furnish and install all refrigerant piping, insulating systems, and accessories, complete, as indicated and specified herein.

B. Without limiting the generality thereof, the work in this section shall include the following items:

1. Direct expansion (DX) system piping (cooling only and heat pump)
2. Insulating the following systems:
    a. Refrigerant suction (low pressure gas) piping
    b. Refrigerant hot gas (discharge or high-pressure gas) piping
    c. Refrigerant liquid piping for VRF/VRV and Heat Pump systems
    d. Refrigerant liquid piping for ductless split systems
3. Testing of refrigerant piping systems

1.3 RELATED DOCUMENTS

A. Specification sections:

1. 23 81 28 Split System Heat Pumps
2. 23 81 28.12 Ductless Cooling Only Split Systems
3. 23 81 28.13 Ductless Split System Heat Pumps

1.4 RELATED REFERENCES

A. Designation and Safety Classification of Refrigerants (ANSI/ASHRAE Standard 34-Latest Edition).

B. Safety Standard for Refrigeration Systems (ANSI/ASHRAE Standard 15-Latest Edition).

1.5 QUALITY ASSURANCE

A. Installer Qualification: Only trained and experienced installers skilled in refrigeration pipe installation, Copper-Tube, Pressure-Seal-Joint Fittings, mechanical fittings, and brazing of copper tubing shall be used.

B. Piping, valves, and accessories shall be manufactured in the United States. Submit Certificate of Manufacture with shop drawings.

1.6 SUBMITTALS

A. Product Data: For each type of fitting, valve, and refrigerant piping specialty indicated. Include pressure drop based on manufacturer's test data.

B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, valve arrangements and locations, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.

1. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
2. Manufacturer’s recommendations for piping expansion/contraction with dimensioned installation drawings showing locations on the project floor plans. Locations shall be coordinated with the Construction Documents.

C. Piping materials including Certificate of Manufacture

D. Training certificates for installers of Copper-Tube, Pressure-Seal-Joint Fittings

E. Insulation products, adhesives, coatings, etc. including Material Safety Data Sheets

F. Field quality-control test reports

G. Operation and maintenance data

1.7 PRODUCT STORAGE AND HANDLING

A. Store piping, fittings, insulation, valves, and specialties in a clean and protected area.

B. Piping, tubes, and coils shall be stored with end caps in place to ensure that piping interior and exterior remain clean prior to installation.

PART 2 - PRODUCTS

2.1 REFRIGERANT PIPING

A. Piping shall be:

1. Type “L” hard drawn seamless copper tube conforming to ASTM B88, or
   a. Tube shall be dehydrated, purged with Nitrogen, and tightly capped to insure cleanliness.
   b. Use hard copper where required by code for A2L refrigerants.
2. Type “ACR” (Air Conditioning and Refrigeration) service copper tubing conforming to ASTM B280.
   a. Straight Lengths: ASTM B 75, UNS C12200, H55 Temper (Light Drawn), ACR Bending Quality; Cleaned, Eddy Current Tested, and Plugged per ASTM B 280.
   b. Coiled: ASTM B 280, UNS C12200, O60 Temper (Soft Annealed), ACR, cleaned and capped. Coils shall be dehydrated, purged with Nitrogen, and tightly capped to insure cleanliness. Piping shall be engineered and constructed to support refrigerant to 700 psi @ 250°F.

      1) Acceptable manufacturers:
         a) Streamline/Mueller
         b) Reftekk, Inc.
         c) Linesets, Inc.

d) ACR Green Proshield by Select Manufacturing, Inc.
e) JMF Company
f) NIBCO

B. Joints shall be brazed. Brazing filler metals shall comply with AWS A5.8.

C. Alternate piping/fitting connection system:

1. Copper-Tube, Pressure-Seal-Joint Fittings:
   a. Copper Press Fittings: Refrigerant Grade Copper (UNS C12200 min. 99.9% pure copper for body) for use with Type ACR, Hard Drawn Type K, and L, and Soft Annealed Type K, and L tubing compatible with ASTM Standards noted above.
      1) Continuous operating temperature: Minus 40°F to Plus 250°F (minus 40°C to plus 121°C).
      2) Maximum Rated Operating and Abnormal Pressure: 700 psi (48 bar/4800 kPa).
      3) Burst Pressure: >3X Maximum Operating and Abnormal Pressure: >2100psi/ >144 bar/ >14400 kPa).
      4) Vacuum Pressure Capability: 200 Microns.
      5) Leak Tightness: Helium $\leq 7.5x10^{-7}$ Pa.m^3/s at +20°C and 10 bar.
   b. O-Rings: Factory installed Hydrogenated Nitrile Butadiene Rubber (HNBR) or material compatible with specific refrigerant used.
      1) Temperature Range: Minus 40°F to Plus 284°F (minus 40°C to plus 140°C). Temperature ratings may vary slightly.
   c. Warranty: 10-year manufacturer's warranty for defects in material and workmanship.
2. Tools: Manufacturer's approved jaw(s) and tool: Approved jaws display two circular 360 deg (400 g) press bands with circular groove on either side, along with a manufacturer's witness mark embossed on the bands.
   a. Maximum Allowable Working Pressure: In accordance with UL 207: 700 psig (48 bar).
   b. Minimum Allowable Burst Pressure: In accordance with UL 207: 2100 psig (145 bar).
3. Basis-0f-Design Product: Subject to compliance with the requirements herein, RLS, LLC, Rapid Locking System Press Fittings.
   a. Acceptable alternate press fitting products:
      1) Mueller/Streamline ACR Copper Press Fittings
      2) ZoomLock MAX by Parker Hannifin, Sporlan Division
      3) NIBCO Inc. ACR Copper Press Fittings
4. Alternate Product: RCS as produced by Refrigerant Coupling Systems, Inc.
   a. Brass Body mechanically attached fittings, ETL Listed, per UL-207 with an allowable working pressure of 1,167 psi.: Refrigerant Coupling Systems, Inc. (RCS) couplings, reducers, and flare fittings.
   b. Primary seal shall be metal to metal seal.
   c. Field Bends (all angles): ASME B31.5.
   d. Bend, install, and join per manufacturer guidelines and specifications.
   e. Warranty: 10-year manufacturer's warranty for defects in material and workmanship.

2.2 VALVES, FITTINGS AND SPECIALTIES

A. Fittings shall be wrought copper conforming to ASME/ANSI Standard B16.

B. Valves, filter-driers, and other accessories shall be suitable for refrigerant service.

C. Field Swaged Brazing Cups: MSS-SP-73, ASME B 16.50

D. Field Bends (all angles): ASME B31.5

E. Full Port Refrigeration Service Valves:

1. Body: Forged brass uni-body style with brass cap including key end to remove core
2. Schrader service valve with cap
3. Core: Removable ball-type check valve with stainless-steel spring
4. Seat: Polytetrafluoroethylene
5. End Connections: Socket ends
6. Working Pressure Rating: 700 psig (factory tested)
7. Maximum Operating Temperature 300°F
8. Valves must be specifically rated for equipment refrigerant
9. Approved manufacturers: Diamondback, Parker, RLS, Mueller/Streamline

2.3 INSULATION

A. Refrigerant piping shall be insulated as follows:

1. Refrigerant Piping Installed Outdoors: shall be insulated with flexible elastomeric tubing insulation with factory applied UV resistant durable protective jacket; Armaflex Shield™ continuous coil pipe insulation as manufactured by Armacell, LLC or alternates listed below, when the product is available in the required pipe size and insulation wall thickness (k-factor: 0.25 hr•ft²•°F/Btu (0.036 m²•°C/W) at 75°F (24°C) mean temperature). Polyethylene (PE) insulation is not acceptable. No field applied protective coating or finish shall be used with this insulation. Longitudinal and butt joints shall be sealed per manufacturer's installation instructions.
   a. Acceptable alternate elastomeric product:
      1) K-Flex USA; K-Flex Titan™ (k-factor: 0.23 hr•ft²•°F/Btu (0.035 m²•°C/W) at 75°F (24°C) mean temperature).
      2) Mueller Streamline Duraguard UV (k-factor: 0.242 hr•ft²•°F/Btu (0.035 m²•°C/W) at 75°F (24°C) mean temperature).
2. Refrigerant Piping Installed Indoors: shall be insulated with flexible elastomeric tubing insulation; AP/Armaflex Black LapSeal™ pipe insulation as manufactured by Armacell, LLC or alternates listed below (k-factor: 0.245-0.28 hr•ft²•°F/Btu (0.035 m²•°C/W) at 75°F (24°C) mean temperature). Polyethylene (PE) insulation is not acceptable. All joints and seams shall be sealed weathertight with Armaflex Black LapSeal™ Tape. Black LapSeal™ Tape shall also be used to secure the thermostat cable to the pipe insulation prior to applying the finish coat. The finish coat for this flexible elastomeric insulation when installed outdoors shall be two coats of a water-based latex paint designed for use over all forms of flexible elastomeric insulation. Finish coat shall provide a protective finish suitable to both indoor and outdoor applications, formulated for cold weather flexibility to resist cracking and weather-resistant to ultraviolet (UV) and ozone. Coating shall be Armaflex WB finish or equivalent product compatible with the insulation.
   a. Acceptable alternate products:
      1) Aeroflex, USA, Inc.; Aerocell-SSPT™ (k-factor: 0.245 hr•ft²•°F/Btu (0.035 m²•°C/W) at 75°F (24°C) mean temperature) with Protape and two coats of field applied Aerocel Aerocoat. (Aerocel Aerocoat required for outdoor installation only).
      2) K-Flex USA, LLC., K-Flex Insul-Lock DS (k-factor: 0.245 hr•ft²•°F/Btu (0.035 m²•°C/W) at 75°F (24°C) mean temperature) (indoor use only).
      3) Mueller Streamline elastomeric insulation (k-factor: 0.245 hr•ft²•°F/Btu (0.035 m²•°C/W) at 75°F (24°C) mean temperature) (indoor use only).
3. Fittings, valves, and specialties shall be insulated with factory formed sectional units of the materials listed above.
4. Insulation that is outdoors and not directly exposed to sunlight (i.e., piping is enclosed in a prefabricated duct system) does not require the UV protective coating.
5. Insulating systems above are to be considered as a minimum. Air conditioning system manufacturer's recommendations take precedence over the insulation materials listed above. Submit air conditioning manufacturer's installation instructions and insulation product data for review and approval.

B. Insulation thickness shall be as follows:

1. Traditional Cooling Only Split Systems (TXV located at indoor unit) – Insulate suction piping only:
   a. All pipe sizes 1/2" insulation
2. Traditional Heat Pump Split Systems (TXV located at indoor unit) – Insulate suction piping only:
   a. <1-1/2" pipe 1" insulation
   b. 1-1/2"<4" pipe 1-1/2" insulation
3. Mini-Split Cooling Only (TXV located at outdoor unit) – Insulate all piping – 1" insulation
4. Mini-Split Heat Pump (TXV located at outdoor unit) – Insulate all piping – 1" insulation

2.4 DETECTION AND MITIGATION

A. Provide complete factory installed UL listed A2L refrigerant detection and mitigation system for each split system.

PART 3 - EXECUTION

3.1 GENERAL

A. Refrigerant piping shall be supported as shown on the Drawings and as required at intervals not over 8'-0" O.C. and at all turns and offsets. Hangers and pipe clamps shall be copper plated tubing hangers of adequate size to fit around tubing and insulation as required. Saddles shall be used under insulated tubing to protect insulation. Piping routed more than 6 (six) lineal feet on the roof shall be supported by B-Line “Dura-Blok” rooftop supports or approved equal.

B. Piping carrying A2L refrigerant shall be routed in a fire-rated shaft when penetrating two (2) or more floors or by alternate means as indicated on the drawings. Piping and joints within shafts shall be exposed for visual inspection and testing prior to being covered or enclosed.

C. Refrigerant piping shall be clean and free of outside contaminants at all times. Prior to start-up of any equipment or insulation installation, all piping shall be cleaned, tested, dehydrated and charged as recommended by the refrigerant compressor manufacturer.

1. Procedure: Joints and connections in refrigerant piping shall not be installed in partitions or walls or where inaccessible for testing, inspection and rework. Make provisions to prevent contact of dissimilar metals. During construction, cap all tubing to prevent moisture from entering. Keep in dry location.
2. Leak testing and recharging: Upon completion of installation of air conditioning equipment, test all refrigerant piping, components and accessories, including quick-connect refrigerant connectors for evaporator and condensing unit; test with a halide torch; prove tight by Contractor to assure a leak-tight refrigerant system. If leaks are detected at the time of installation or during warranty period, remove entire refrigerant charge from system, correct leaks, and retest system. After system is found to be leak free, evacuation shall be accomplished by use of a reliable gauge and a vacuum pump capable of pulling vacuum of at least one mm Hg absolute. Accomplish system evacuation in strict accordance with equipment manufacturer’s printed instruction. System leak testing, evacuation, dehydration and charging with refrigerant shall comply with standard industry practice and local codes and ordinances.

D. Refrigerant piping shall be run continuously, without joints, where possible. All joints in refrigerant piping shall be made accessible. Joints shall not be permitted in concrete slabs or below grade.

E. Refrigerant circuit access ports located outdoors shall be fitted with locking-type tamper-resistant caps or shall be otherwise secured to prevent unauthorized access.

F. All piping shall be run true to grade and shall be arranged to make the best possible appearance. Except where otherwise required by conditions of installation, all piping shall be symmetrical and parallel with lines of buildings or structure in which it is installed. All piping shall be run concealed except in mechanical room and where indicated otherwise.

G. All piping and equipment shall be supported and guided. Anchors shall be provided to absorb or transmit thrust and eliminate vibration or pulsation. Hangers or supports shall be provided near each change of direction. Supports shall be so located or shall be of such type as not to unduly restrict the movement of the pipe due to lateral or longitudinal expansion.

H. Provisions shall be made for expansion and contraction in the piping system. Install in conformance with manufacturer's guidelines.

3.2 TESTING

A. Refrigerant piping systems carrying A2L refrigerant shall be tested in accordance with both of the following two methods:

1. The system shall be pressurized for a period of not less than 60 minutes to not less than the lower of the design pressures or setting of the pressure relief device(s). The design pressures for testing shall be the pressure listed on the nameplate of the condensing unit, compressor, compressor unit, pressure vessel or other system component with a nameplate. Additional test gas shall not be added to the system after the start of the pressure test. The system shall not show loss of pressure on the test pressure measuring device during the pressure test. The refrigerant identified on the equipment nameplate may be used as a test medium for systems erected on the job site provided the tubing does not exceed 5/8 inch (15.9 mm) outside diameter (OD). Otherwise, one of the following inert gases must be used: oxygen-free nitrogen, helium or argon. The test pressure shall be not less than the saturation dew point pressure at 77°F (25°C).
2. A vacuum of 500 microns shall be achieved. After achieving a vacuum, the system shall be isolated from the vacuum pump. The system pressure shall not rise above 1500 microns for a period of not less than 10 minutes.

B. The installing contractor shall issue a certificate of test to the code official for all systems containing 55 pounds (25 kg) or more of refrigerant. The certificate shall give the test date, name of the refrigerant, test medium and field test pressure applied to the high-pressure side and the low-pressure side of the system. The certificate of test shall be signed by the installing contactor and shall be made part of the public record.

3.3 PIPING APPLICATIONS

A. Suction (low pressure gas), Hot Gas (high pressure gas) and Liquid Lines 7/8" OD and Smaller for Conventional Air-Conditioning, Heat Pump, and Heat Recovery Applications: Copper, Type ACR, O60 (soft annealed)-temper tubing and field bent fittings with brazed joints.

B. Suction (low pressure gas), Hot Gas (high pressure gas), and Liquid Lines 2-1/8" OD and smaller for Conventional Air-Conditioning, Heat Pump, and Heat Recovery Applications: Straight Lengths, Copper, Type ACR Type L, H55 (light drawn)-temper tubing and field bent fittings with brazed joints.

3.4 VALVE AND SPECIALTY APPLICATIONS

A. Install service valves as specified or as required to isolate system components.

3.5 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; route and size piping based on manufacturer's recommended line lengths and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping according to ASHRAE Standard 15 (latest version).

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas. Concealed locations shall be free of pipe joints.

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

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

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Field bend changes in direction shall be smooth with no kinks in piping.

I. Select system components with pressure rating equal to or greater than maximum allowable working pressure.

J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Coordinate with architectural drawings for installation of access doors or panels as specified in Division 08 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

L. Provide jacketed insulation in locations where exposed to mechanical injury.

M. When brazing, remove solenoid-valve coils and sight glasses; also, remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulbs.

N. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 23 00 00 HVAC General.

P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 23 00 00 HVAC General.

Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 00 00 HVAC General.

R. Provide proper compensation for pipe/tube expansion and contraction per equipment manufacturers recommendations.

S. Piping carrying group A2L and B2L refrigerants where located in concealed locations (e.g. studs, joists, rafters, etc.) or similar member spaces and located less than 1½" from the nearest edge of the member, shall be continuously protected by shield plates. Protective steel shield plates having a minimum thickness of 0.0575 inch (No. 16 gauge) shall cover the area of the tube plus the area extending not less than 2 inches beyond both sides of the tube.

T. Refrigerant pipe enclosure – refrigerant piping that is outdoors and exceeds a distance of 6 (six) lineal feet from exiting the building to the outdoor equipment shall be enclosed within a protective piping enclosure; Diversitech SpeediChannel, Rectorseal Slimduct or approved equal.

U. Refrigerant piping identification – refrigerant piping located in areas other than the room or space the refrigerating equipment is located shall be identified. Label piping and/or insulation at 20 (twenty) foot intervals with factory fabricated labels having a minimum ½" high lettering.

1. The letter size and background color shall conform to ANSI/ASME A13.1 Standard for the Identification of Piping Systems.
2. The labeling system shall consist of UV resistant vinyl tapes and labels suitable for indoor/outdoor use be as manufactured by Seton, Brady, or DuraLabel by Graphic Products.
3. For Group A2, A3, B2, and B3 refrigerants, the identification shall include the following statement “DANGER – Risk of Fire or Explosion. Flammable Refrigerant.” For any Group B refrigerant, the identification shall also include the following statement “DANGER – Toxic Refrigerant.”

3.6 PIPE JOINT CONSTRUCTION

A. Brazed Joints: Construct joints according to AWS’s “Brazing Handbook,” Chapter “Pipe and Tube”.

1. Use Type BcuP-5 (15% Ag, 80% Cu, 5% P), copper-phosphorus alloy pre-formed brazing rings for joining copper swage fittings and copper socket fittings with copper pipe. Do NOT use flux.
2. Use Type Bag-5 (45% Ag), cadmium-free silver alloy for joining copper with bronze or steel. Use manufacturer’s recommended flux.

B. Field Swaged Brazing Cups: Fabricate brazing cup on one tubing end for each coupling. Only O60 (soft annealed) and H55 (light drawn) may be swaged. Do NOT swage H58 (drawn general purpose). Use swaging tool designed to provide a minimum of 0.0015" brazing gap and a maximum of 0.005" brazing gap. Brazing cup depth for each tube size shall be as follows:

1/4"	3/8"	1/2"	5/8"	3/4"	7/8"	1-1/8"	1-3/8"	1-5/8"	2-1/8"
0.250"	0.280"	0.310"	0.390"	0.420"	0.460"	0.510"	0.560"	0.600"	0.700"

C. Field Bends: Fabricate field bends with a center-line bend radius greater than or equal to 4 times the nominal OD of the pipe or tube. Tube shall be bent with a tubing bender sized for ACR OD tube sizes and shall not cause cracks or wrinkles in the tube or pipe. Do NOT use a conduit bender for bending ACR copper. The difference between maximum and minimum diameters for pipe bends should not exceed 8% of the nominal outside diameter of the pipe. Only O60 soft annealed-temper and H55 light drawn-temper shall be field bent. Do NOT field bend H58 drawn general purpose-temper copper tube.

D. Brazing and joining procedure:

1. Tube ends shall be cut with a clean sharp tubing cutter.
2. Deburr the I.D. of the cut tube end with a clean deburring tool.
3. Visually inspect the interior of each tube for obstructions and debris before assembly. Protect the joint from contamination before brazing.

4. Method of pre-cleaning: Non-shedding abrasive pads (Scotch Bright) to remove all oxides in the brazing area followed by wiping with a clean lint-free white cloth. Do not groove the surfaces while cleaning.
5. Purge all tubing with oil free nitrogen while brazing and until cool to the touch. Use an oxygen analyzer to verify the absence of oxygen prior to brazing. The oxygen content shall be less than 1% before start of brazing.
6. Use a neutral to slightly reducing flame using oxy/acetylene or oxy/propane.
7. Use the proper torch tip based on tube size as recommended by the torch manufacturer. Use of Turbo-Torch or Rosebud is permitted.
8. Post Brazing Cleaning: Exterior of all completed joints shall be washed with a water-soaked rag or sponge, followed by brushing with a stainless-steel hand wire brush to remove any residue for inspection.

E. Copper-Tube, Pressure-Seal-Joint Fittings:

1. Install fittings in strict accordance with manufacturer's installation instructions.
2. Installers shall be trained and certified by the manufacturer.
3. Test piping system according to manufacturer's recommendations and prepare a test report to be turned over to the Owner for their records.

F. Mechanically Attached Joints:
1. Mechanically Attached Joints: Construct joints with approved mechanically attached fittings as described above.
2. JOINING PROCEDURE:
   a. Tube ends shall be cut with a clean sharp tubing cutter.
   b. Deburr the I.D. of the cut tube end with a clean, sharp deburring tool.
   c. Visually inspect the interior of each tube for obstructions and debris before assembly. Protect the joint from contamination before assembly.
   d. Visually inspect the exterior of each tube end receiving a fitting. This tube end must be clean, free of burrs, scratches, pits, or deformation. End of fitting must be round.
   e. Install joint in strict compliance with Refrigerant Coupling Systems, Inc. installation instructions.

3.7 HANGERS AND SUPPORTS

A. Piping hangers and supports must accommodate expansion and contraction,vibration, dead load of piping and its contents, and seismic-bracing requirements.

B. Install the following pipe attachments or combination thereof:

1. Adjustable steel clevis hangers for individual horizontal runs.
2. Channel strut or angle iron trapeze for multiple horizontal runs
3. Galvanized steel saddle with attachment screw for channel strut applications
4. Rigid high compressive strength foam insulating pipe support at all clamps and support points.
5. Rigid high compressive strength foam pipe support at all riser clamps.
6. Do NOT attach hangers directly to pipe or tube.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:

1. Up to 3/4" OD: Maximum span, 60 inches; minimum rod size, 3/8 inch.
2. Greater than 3/4" thru 1" OD: Maximum span, 72 inches; minimum rod size, 3/8 inch.
3. Greater than 1" thru 2-1/8" OD: Maximum span, 96 inches; minimum rod size, 3/8 inch.

D. Support multi-floor vertical runs every 10 feet and at least at each floor with riser clamps or as indicated.

3.8 FIELD QUALITY CONTROL AND TESTING

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test as follows or as recommended by the equipment manufacturer's installation instructions for refrigerant:
   a. Line Test Pressure:
      1) Suction (low pressure gas) Lines: 550 psig, or per equipment manufacturers recommendation.
      2) Hot-Gas (high pressure gas) and Liquid Lines: 550 psig, or per equipment manufacturers recommendation.
3. Test refrigerant piping and specialties. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
   a. Fill system with APPROVED TEST MEDIUM to the required test pressure.
   b. System shall maintain test pressure at the manifold gage throughout duration of test.
   c. Test all joints and fittings with hydrogen leak detector, at test pressure.
   d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

C. Refrigerant piping systems carrying A2L refrigerant shall be tested in accordance with both of the following two methods:

1. The system shall be pressurized for a period of not less than 60 minutes to not less than the lower of the design pressures or setting of the pressure relief device(s). The design pressures for testing shall be the pressure listed on the nameplate of the condensing unit, compressor, compressor unit, pressure vessel or other system component with a nameplate. Additional test gas shall not be added to the system after the start of the pressure test. The system shall not show loss of pressure on the test pressure measuring device during the pressure test. The refrigerant identified on the equipment nameplate may be used as a test medium for systems erected on the job site provided the tubing does not exceed 5/8 inch (15.9 mm) outside diameter (OD). Otherwise, one of the following inert gases must be used: oxygen-free nitrogen, helium or argon. The test pressure shall be not less than the saturation dew point pressure at 77°F (25°C).
2. A vacuum of 500 microns shall be achieved. After achieving a vacuum, the system shall be isolated from the vacuum pump. The system pressure shall not rise above 1500 microns for a period of not less than 10 minutes.

D. The installing contractor shall issue a certificate of test to the code official for all systems containing 55 pounds (25 kg) or more of refrigerant. The certificate shall give the test date, name of the refrigerant, test medium and field test pressure applied to the high-pressure side and the low-pressure side of the system. The certificate of test shall be signed by the installing contactor and shall be made part of the public record.

3.9 SYSTEM CHARGING

A. Charge system using the following procedures and per equipment manufacturer's installation instructions.

1. Evacuate (triple evacuation procedure) entire refrigerant system with a vacuum pump to obtain a steady state vacuum of less than 500 micrometers. If vacuum holds for 12 hours, system is ready for charging. Do NOT evacuate the system through a charging manifold. Use only suction rated hoses and core removal tools.
2. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
3. Charge system as recommended by equipment manufacturer.

3.10 OWNER REVIEW OF MAINTENANCE REQUIREMENTS

A. Review manufacturer's maintenance instructions with the owner's representative to make them aware of any reoccurring maintenance requirements such as recoating piping insulation, lubricating service valves, etc.

B. Submit any required testing reports to the owner with other closeout documentation.

END OF SECTION

SECTION 23 31 00

DUCTWORK AND ACCESSORIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. All work in this section shall be subject to the provisions of Section 23 00 00 - HVAC General.

B. Furnish and install all material, labor, accessories, etc. shown on the drawings and as specified herein to completely install all ductwork systems.

C. Ductwork systems shall be classified as follows:

1. Static pressure class +2 in. wg - from constant volume air handling unit to supply diffusers; all return, outside air and exhaust ductwork.

D. Refer to PART 3 – EXECUTION for duct sealing requirements.

E. Ductwork shall be constructed according to the latest edition of SMACNA ductwork construction standards applicable to the type of ductwork, system pressures described above, and the system material construction.

F. Duct sizes shown on the drawings are nominal inside clear.

1.2 RELATED DOCUMENTS

A. Specification sections:

1. 23 37 00 Louvers, Grilles, Registers and Diffusers

1.3 QUALITY ASSURANCE

A. Fire, smoke, combination fire/smoke and radiation dampers shall be installed and maintained in accordance with:

1. Manufacturer’s installation instructions
2. UL approved installation instructions and supplemental instructions
3. UL Damper Marking and Application Guide, latest edition.
4. NFPA Standard 90A (latest edition)
5. SMACNA’s Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems (latest edition)

B. Control (balancing and shut-off) dampers shall be certified in accordance with:

1. AMCA Standard 500-D, Laboratory Methods of Testing Dampers for Rating
2. AMCA Publication 511, Certified Ratings Program – Product Rating Manual for Air Control Devices

1.4 SUBMITTALS

A. Product Data:

1. Duct materials:
   a. Fiberglass ductboard
   b. Outdoor duct systems

c. Flexible duct connectors
d. Flexible ductwork

2. Dampers and accessories
3. Remote damper operators
4. Access doors
5. Flexible duct connectors
6. Duct liner
7. Sealants, mastics, adhesives and coatings

B. For all fire dampers, combination fire and smoke dampers, and smoke dampers, submit UL approved installation instructions for each specific application.

PART 2 - PRODUCTS

2.1 DUCTWORK

A. Ductwork shall be constructed of galvanized steel sheets of the thickness listed in the SMACNA manuals for the pressures referenced above, or of 1" thick (1½" thick if required by the applicable energy code) resin-bonded fiberglass duct board with fire-resistive foil-scrim-kraft (FSK) vapor retarder on the outside surface and a smooth mat finish on the air-side surface. Fabrication and installation shall conform to SMACNA's Fibrous Glass Duct Construction Standards; latest edition. See below for additional requirements.

B. Single-Wall Rectangular Ducts and Fittings:

1. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
2. Transverse Joints: Select joint types and fabricate per SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," "Transverse (Girth) Joints," for static pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   a. Alternate Product: Subject to compliance with requirements, provide Ductmate Industries, Inc.; 25/35/45 Rectangular Flange System or comparable product by one of the following:
      1) Nexus PDQ; a division of Shilco Holdings, Inc.
      2) Ward Industries, Inc; a division of Hart & Cooley, Inc.
      3) Prior Approved Equal
   b. Slide-on Flanges:
      1) Description: Roll-formed, add on, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
      2) Material: galvanized steel
      3) Gauge and Shape: For duct constructed using prefabricated systems, refer to the manufacturer's guidelines for sheet gauge, intermediate reinforcement size and spacing, and proper joint reinforcement.
      4) Manufacturers of prefabricated systems must provide duct construction and reinforcement guidelines along with independent testing for leakage, deflection, and seismic performance.
      5) Independent leakage testing must be provided for systems operating at pressures of 10 in. wg (or greater) positive or negative.
      6) Manufacturer's prefabricated systems printed assembly and installation procedures must be adhered to at all times.
      7) Manufacturer's procedures must include fastener and cleat spacing along with details for all system variations including break-away and roofing connections.

8) All manufactured system components must be clearly embossed with manufacturer's name or markings. Substitution of manufacturer's system components is not permitted.

c. Formed flanges will be accepted on ductwork 42 inches wide or less and subjected to 2 in. wg static positive pressure or less.

1) Formed on Flanges: Construct as T-25 A/B flanges, of which construction guidelines are given in Figure 2-1 of the 2005 SMACNA "HVAC Duct Constructions Standards, Metal and Flexible." No other construction standards pertaining to formed on flanges will be accepted.

2) Formed on flanges must include the use of corners, securely crimped in place, bolts, cleat, and gasket.

3. Longitudinal Seams: Select seam types and fabricate per SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," "Longitudinal Seams – Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards – Metal and Flexible."

4. Snap-lock longitudinal duct seams are not allowed in public spaces unless secured with sheet metal fastening screws as recommended by SMACNA.

5. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate per SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Single-Wall Round and Flat-Oval Ducts and Fittings

1. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

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

1) Linx Industries
2) McGill AirFlow, LLC
3) SEMCO, LLC
4) Sheet Metal Connectors, Inc.
5) Spiral Manufacturing Co., Inc.
6) Prior Approved Equal

2. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

3. Transverse Joints: Select joint types and fabricate per SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

a. Transverse Joints in Ducts Larger Than 50 Inches in Diameter: Flanged.

1) Unexposed Duct 3 inches to 30 inches in diameter: Round duct connects with a one-piece interior slip coupling at least two gages heavier than duct wall, beaded at center and fastened to duct with screws. Seal joint with an approved sealant applied continuously around both ends of coupler prior to assembling and after fastening.

2) All Exposed Duct and Unexposed Duct 30 inches to 72 inches in diameter: Three-piece, gasket flanged-joint consisting of two internal flanges, with integral mastic sealant, and one external closure ring, for connecting the internal flanges and securing the closed cell neoprene gasketing in place.

a) Basis-of-Design Product: Subject to compliance with requirements, provide Ductmate Industries, Inc.; Spiralmate or similar comparable product by one of the following:
(1) Prior Approved Equal

3) Ducts larger than 72 inches in diameter: Use companion angle flanged joints as defined in Figure 3-1 for the 2005 SMACNA Manual "HVAC Duct Construction Standards, Metal and Flexible" Third Edition. Refer to manual for proper sizing and construction details.

4) Dust Collection Systems and Exposed Duct 3 inches to 14 inches in diameter: Use a one-piece, polyethylene lined gasket connector with integrated bolt for the closure system.

a) Basis-of-Design Product: Subject to compliance with requirements, provide Ductmate Industries, Inc.; Quicksleeve or comparable product by one of the following:
(1) Prior Approved Equal

4. Longitudinal Seams: Select seam types and fabricate per SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   a. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
   b. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
5. Tees and Laterals: Select types and fabricate per SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Double-Wall Round and Flat-Oval Ducts and Fittings

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Linx Industries
   b. McGill AirFlow, LLC
   c. SEMCO, LLC
   d. Sheet Metal Connectors, Inc.
2. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.
3. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
   a. Transverse Joints: Select joint types and fabricate per SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
      1) Transverse Joints in Ducts Larger Than 50 inches in Diameter: Flanged.
         a) All Exposed Duct and Unexposed Duct 30 inches to 72 inches in diameter: Three-piece, gasket flanged-joint consisting of two internal flanges, with integral mastic sealant, and one external closure ring for connecting the internal flanges and securing the closed cell neoprene gasketing in place.

b) Basis-of-Design Product: Subject to compliance with requirements, provide Ductmate Industries, Inc.; Spiralmate or comparable product by one of the following:
(1) Prior Approved Equal

b. Longitudinal Seams: Select seam types and fabricate per SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
1) Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
2) Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

c. Tees and Laterals: Select types and fabricate per SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

4. Inner Duct: Minimum 0.028-inch (24 gauge) perforated galvanized sheet steel having 3/32-inch diameter perforations, with an overall open area of 23 percent.
5. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard".
a. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x ºF at 75ºF mean temperature.
b. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
c. Coat insulation with antimicrobial coating.
d. Cover insulation with polyester film complying with UL 181, Class 1.
6. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C 534, Type II for sheet materials, and with NFPA 90A or NFPA 90B.
a. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x ºF at 75ºF mean temperature.

E. When detailed, round and oval ductwork shall be supported using galvanized wire rope cable and locking cable terminations. The locking cable terminations shall have an Ultimate Breaking Strength (U.B.S.) of at least 5 times the published Working Load Limit (W.L.L.). Wire ropes and locking cable terminations shall be sized, spaced, and furnished by the manufacturer. Submit layout drawings and product data during the submittal phase. Wire rope and locking cable terminations shall be Dynatite Suspension System as manufactured by Duro Dyne Corporation or Cable Shark as manufactured by Ductmate.

F. Rectangular sheet metal duct elbows shall be smooth radius type without turning vanes or square (or mitered) type with turning vanes. Sharp throat elbows (ASHRAE Fitting No. CR3-2) shall not be permitted. Round sheet metal duct elbows shall be smooth radius type without turning vanes, gored type or mitered type with turning vanes.

G. Unless otherwise indicated, elbows shall have a centerline radius of not less than 1½ times the width of the duct. Where space limitations necessitate use of short radius or square elbows, provide turning vanes.

H. Fiberglass duct board shall be UL 181 listed as a Class 1 Rigid Air Duct with a thermal conductivity not to exceed 0.23 at 75°F per ASTM C 518. Thickness shall be as indicated on the drawings or as required by the energy code in effect. Fiberglass duct board shall be Johns Manville Super Duct RC,

Knauf Atmosphere Air Duct Board, Owens Corning QuietR Duct Board or Certainteed Ultra*Duct Black Duct Board.

1. Tapes and mastics used to seal fibrous glass ductwork shall be listed and labeled in accordance with UL 181A and shall be marked “181A-P” for pressure-sensitive tape, “181A-M” for mastic or “181A-H” for heat-sensitive tape.

I. Exhaust ductwork shall be galvanized sheet metal (G 90 minimum) constructed to SMACNA standards and shall not be insulated unless noted otherwise.

J. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

K. Exterior supply and return air ductwork shall be constructed of galvanized sheet metal (G 90 minimum) lined with 2" thick 3 lb/ft^3 duct liner board (R-12 min.); Johns-Manville Linacoustic R-300. All seams shall be externally sealed watertight with a 30-year silicone caulk and coated with a rust preventive coating over the entire duct surface. Rust preventative coating shall be “Rust Destroyer” by Advanced Protective Products, Inc., or approved equal. As an alternative to insulated sheet metal, an outdoor duct system as manufactured by Thermaduct, LLC may be used. The system shall incorporate duct and fittings having an installed minimum R-value of 12. The system shall utilize non-fibrous closed cell Kingspan KoolDuct fortified inner liner compliant to UL (C-UL) 181, Standard for Safety Listed, Class 1 system and SMACNA Class 1 leakage, or less. Submit product data and layout drawings during the submittal phase. Crown or slope ductwork at ¼" per foot transversely to prevent standing water on top of ductwork. For projects located within 2 miles of the seacoast, flanges and hardware shall be aluminum (alloy 3003 - H14 temper per ASTM B209).

L. Supply and exhaust ductwork serving swimming pool equipment and chemical storage rooms shall be 16-gauge aluminum (alloy 3003 - H14 temper per ASTM B209).

M. Support roof mounted ductwork at 6 feet (max.) on center with Mifab Series DSA duct support system. UV resistant rubber bases shall be placed on roofing walk pad material. Coordinate with general contractor and roofing installer. Manufacturer shall submit layout drawings and product information during the submittal phase.

2.2 FLEXIBLE DUCTWORK

A. Flexible ducts shall be listed and labeled as UL Standard 181 Class 1 air duct. Air connectors are not allowed.

B. Flexible ductwork shall comply with the following:

1. NFPA 90A, “Installation of Air Conditioning and Ventilating Systems”
2. NFPA 90B, “Installation of Warm Air Heating and Air Conditioning Systems”
3. SMACNA's “HVAC Duct Construction Standards - Metal and Flexible” for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated.
4. Air Diffusion Council's “ADC Flexible Air Duct Test Code FD 72-R1”.
5. ASTM E 96/E 96M, "Test Methods for Water Vapor Transmission of Materials."

C. Flexible ductwork shall be installed between main supply ducts and diffusers. Length shall be a maximum of 8'-0" long, except in residential applications, where the length shall be as indicated.

D. Flexible ductwork shall be Thermaflex M-KE R-6 (R value = 6.0 minimum or as required by local energy code) flexible air duct or equal by Quietflex, Flexmaster, Atco, JP Lamborn, or Royal Metal Products. Provide R-8 when located outside the thermal envelope.

E. Flexible ductwork size shall be the same size as the diffuser neck it serves, unless indicated otherwise.

F. **Common Area -** Take-offs for sheet metal ductwork shall be made using a conical spin-in type fitting with manual balancing damper.

G. **Residential** - Take-offs for fiberglass ductboard shall be made using a starting collar fitting with crimp and bead (tab type).

H. Flexible duct connections to ceiling diffusers shall be installed without kinks or sags to provide unrestricted airflow. Provide Flex Flow Elbow supports by Thermaflex or FlexRIGHT elbow support by Build Right Products.

I. Tapes and mastics used to seal metallic and flexible air ducts shall comply with UL 181B and shall be marked "181B-FX" for pressure-sensitive tape or "181B-M" for mastic.

J. Mechanical fasteners for use with flexible nonmetallic air ducts shall comply with ul 181b and shall be marked "181B-C".

2.3 LIFE SAFETY DAMPERS

A. General

1. Fire, smoke, combination fire/smoke and radiation dampers shall have the installation approved by the Authority Having Jurisdiction (AHJ) where field modifications are necessary as part of the manufacturer's supplemental instructions.
2. Modifications must be made per the manufacturer's installation instructions.
3. Some modifications fall under UL approval, some need AHJ approval.
4. Contact the manufacturer for guidance on modifications. The manufacturer will point out approved modifications and modifications needing AHJ approval. Manufacturers can also help explain the impact of modifications to the AHJ.
5. All dampers are recommended to be cycled after any modification.
6. UL Life Safety Damper actuators shall be factory installed and cycle-tested prior to shipment. Field mounting or substitutions of a damaged actuator is not covered under the UL certification and thus replacement shall be completed in accordance with the damper manufacturer's field service program.

2.4 FIRE DAMPERS

A. Fire dampers shall be installed at all locations where ductwork or supply or return air openings penetrate any floor, wall or partition with a fire rating.

B. All fire dampers shall be of the "Dynamic" type as classified in UL Standard 555.

C. Fire dampers shall have a rating compatible with the floor, wall or partition, shall be tested to UL Standard 555 and be labeled for the intended installation (horizontal or vertical).

D. Fire Resistance Rating: 1½ hours unless noted otherwise indicated on drawings for 3 hours.

E. Closure device: Each fire damper shall be equipped with a factory installed heat responsive device (fusible link) rated to close the damper when temperature at the damper reaches: 165°F.

F. Airflow Closure Rating:

1. Dynamic fire dampers shall be selected for the velocity and pressure rating of the intended installation. Refer to the plans and schedules for airflow rates (CFM) and pressures (in. wg).
2. Dampers shall have a minimum velocity rating of 2000 fpm at a pressure rating of 4 in. wg.
3. Dampers in systems operating above 2000 fpm or 4 in. wg shall be selected for a velocity rating of 4000 fpm at a pressure rating of 6 in. wg.

G. Types:

1. Curtain: for use in systems up to 4000 fpm velocity; Style B or C with the blade stack out of the airstream (Style A with the blade stack in the airstream may be used behind registers and grilles or where space conditions do not permit the use of a Style B damper).
   a. Construction:
      1) Frame: Galvanized steel (in gauges required by manufacturer's UL listing).
      2) Blade design: interlocking galvanized steel
      3) Sleeves: Damper shall be supplied as a single assembly with a factory sleeve.
      4) Retaining Angles: Damper shall be supplied with factory retaining angles sized to provide installation overlap in accordance with the manufacturer's UL listing.
      5) Duct Transition Connection: breakaway type
2. Round: for use in systems up to 2000 fpm velocity.
   a. Construction:
      1) Frame: Galvanized steel (in gauges required by manufacturer's UL listing).
      2) Blade design: single galvanized steel blade (in gauge required by manufacturer's UL listing).
      3) Retainer plate(s): supplied with damper.
      4) Sleeves: Length as required per wall thickness.
      5) Duct Transition Connection: breakaway type.
3. Multi-blade:
   a. Up to 2000 fpm velocity: Triple vee-groove type blade.
   b. 2000-4000 fpm velocity: Fabricated double skin airfoil type blade.
   c. Construction:
      1) Frame: Galvanized steel interlocking corners (in gauges required by manufacturer's UL listing).
      2) Blade design: Galvanized steel (in gauges required by manufacturer's UL listing) strengthened by three longitudinal Vee grooves running the entire length of each blade as required by manufacturer's UL listing.
      3) Sleeves: Damper shall be supplied as a single assembly with a factory sleeve.
      4) Retaining Angles: Damper shall be supplied with factory retaining angles sized to provide installation overlap in accordance with the manufacturer's UL listing.
      5) Duct Transition Connection: breakaway type

H. All dampers shall be installed in strict accordance with the manufacturer's UL approved installation details.

I. Where fire dampers are required in a fibrous glass ductboard system, provide sheet metal sleeve per manufacturer's UL installation instructions. Verify gage of sleeve and attachment angle with governing code authorities. Installation shall also conform to SMACNA Figure 5-9 "Fibrous Glass Duct Installation".

2.5 CEILING RADIATION DAMPERS

A. A listed ceiling radiation damper shall be installed at all locations where ductwork or register, diffuser, grille, etc. penetrates the ceiling membrane of a fire-resistance-rated floor/ceiling or roof/ceiling assembly. Ceiling radiation dampers shall have a rating compatible with the floor/ceiling or roof/ceiling assembly and shall be tested to UL Standard 555C.

B. Fire Resistance Rating: 1 hour (minimum).

C. Closure device: Each ceiling radiation damper shall be equipped with a factory installed heat responsive device (fusible link) rated to close the damper when temperature at the damper reaches: 165°F.

D. Construction:

1. Dampers shall be factory-built curtain or butterfly type. They shall conform to the requirements of NFPA Standard 90A and be UL Labeled for the required assembly rating.
2. All dampers shall be installed in strict accordance with the manufacturer's UL approved installation instructions.
3. Provide steel sleeves, mounting angles and steel duct drops of design and length where required to permit mounting within the opening.
4. Provide thermal blanket where required by the manufacturer's UL installation instructions.
5. Where ceiling radiation dampers are shown on the drawings, and if fiberglass ductwork is used, dampers shall be installed with a sheet metal collar or housing or shall be listed for use with fiberglass ductwork.
6. Where fiberglass ductboard plenums are used, they shall conform to manufacturer's Fiberglass Ductboard Plenum Installation Instructions.

2.6 COMBINATION FIRE AND SMOKE DAMPERS

A. Fire/smoke dampers shall be installed at all locations where ductwork or supply or return air openings penetrate any floor, wall or partition with a fire and smoke rating, or where otherwise shown on the drawings.

B. Fire/smoke dampers shall be provided with actuators capable of closing the damper on activation of area smoke detectors, the fire alarm system and/or the Firefighter's Smoke Control Panel and shall be normally closed. Actuators shall be compatible with the activating smoke detectors or fire alarm system (coordinate with other trades).

C. Unless otherwise indicated, smoke detectors integral to the combination fire/smoke damper shall be furnished and installed by the fire alarm contractor (coordinate with other trades).

D. All combination fire/smoke dampers shall be of the "Dynamic" type as classified in UL Standards 555 and 555S.

E. Fire/smoke dampers shall have a rating compatible with the floor, wall or partition, shall be tested to UL Standards 555 and 555S and be labeled for the intended installation (horizontal or vertical).

F. Fire Resistance Rating: 1½ hours unless noted otherwise on drawings for 3 hours.

G. Leakage Rating: Class 1 (maximum of 8 cfm/ft^2 at 4 in. wg) unless noted otherwise.

H. Elevated Temperature Rating: 250°F (121°C) for 30 minutes. For smoke control systems provide provide dampers rated for 350°F (177°C) for 30 minutes.

I. Airflow Closure Rating:

1. Dynamic fire/smoke dampers shall be selected for the velocity and pressure rating of the intended installation. Refer to the plans and schedules for airflow rates (CFM) and pressures (in. wg).
2. Dampers shall have a minimum velocity rating of 2000 fpm at a pressure rating of 4 in. wg.

3. Dampers in systems operating above 2000 fpm or 4 in. wg shall be selected for a velocity rating of 4000 fpm at a pressure rating of 6 in. wg.

J. Types:

1. Round: for use in systems up to 3000 fpm velocity.
   a. Construction:
      1) Frame: Galvanized steel (in gauges required by manufacturer's UL listing).
      2) Blade design: single galvanized steel blade (in gauge required by manufacturer's UL listing).
      3) Retainer plate(s): supplied with damper.
      4) Sleeves: Length as required per wall thickness.
      5) Duct Transition Connection: breakaway type.
2. Multi-blade:
   a. Up to 2000 fpm velocity: Triple Vee-groove type blade.
   b. 2000-4000 fpm velocity: Fabricated double skin airfoil type blade.
   c. Construction:
      1) Frame: Galvanized steel with mitered and interlocking corners (in gauges required by manufacturer's UL listing).
      2) Blade design: Galvanized steel (in gauges required by manufacturer's UL listing) strengthened by three longitudinal Vee grooves running the entire length of each blade as required by manufacturer's UL listing.
      3) Blade Stops: Each blade stop (at top and bottom of damper frame) shall occupy the minimum of the damper opening required by manufacturer's UL listing area to allow for maximum free area and to minimize pressure loss across the damper.
      4) Seals:
         a) Blade Edge: Blade seals shall be extruded silicone rubber permanently bonded to the appropriate blade edges.
         b) Jamb: Flexible stainless-steel compression type.
      5) Linkage: Concealed in jamb.
      6) Axles: Minimum ½" diameter plated steel.
      7) Bearings: Axle bearings shall be sintered bronze sleeve type or stainless- steel rotating in polished extruded holes in the damper frame.
      8) Sleeves: Damper shall be supplied as a single assembly with a factory sleeve.
      9) Retaining Angles: Damper shall be supplied with factory retaining angles sized to provide installation overlap in accordance with the manufacturer's UL listing.
      10) Duct Transition Connection: breakaway type

K. Heat Responsive Device: Electric, controlled closure, quick detect heat-actuated device designed to prevent damage to ductwork and other HVAC system components. The device shall be a reusable/resettable link (RRL) with a temperature setting of 165°F (74°C).

L. No Flow Smoke Detector (if indicated on the drawings): rated for air velocities from 0 to 3000 fpm; UL268A listed, factory mounted internally on the damper sleeve with built-in test switch.

M. Photoelectric [ionization] Type Smoke Detector (if indicated on the drawings): rated for air velocities from 300 [100] to 4000 fpm; UL268A listed, factory mounted internally on the damper sleeve.

N. Damper Motors: Two-position meeting the following:

1. Comply with NEMA designation, temperature rating, service factor, enclosure type, efficiency requirements and the following:
   a. Motor Sizes: Minimum size as required by manufacturer's UL listing.

b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
c. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40°F (minus 40°C).
d. Electrical Connection: 115 V, single phase, 60 Hz.

O. Momentary Test Switch (for use in combination fire and smoke dampers that are not part of a smoke management system): factory mounted and wired assembly for testing and cycling the damper during start-up and maintenance. Power wiring to test switch and actuator shall be per manufacturer's installation instructions.

P. Combination Fire and Smoke Dampers shall have a single point wiring per UL requirements (except where two signals are required as with the Temperature Limited Override specified above).

2.7 CORRIDOR COMBINATION FIRE AND SMOKE DAMPERS

A. Corridor fire/smoke dampers shall be installed at all locations where ductwork or supply or return air openings penetrate any tunnel corridor ceiling with a fire and smoke rating, or where otherwise shown on the drawings.

B. Corridor fire/smoke dampers shall be provided with actuators capable of closing the damper on activation of area smoke detectors, the fire alarm system and/or the Firefighter's Smoke Control Panel and shall be normally closed. Actuators shall be compatible with the activating smoke detectors or fire alarm system (coordinate with other trades).

C. Unless otherwise indicated, smoke detectors integral to the corridor fire/smoke damper shall be furnished and installed by the fire alarm contractor (coordinate with other trades).

D. All corridor fire/smoke dampers shall be of the "Dynamic" type as classified in UL Standards 555 and 555S.

E. Corridor fire/smoke dampers shall be tested to UL Standards 555 and 555S and be labeled for the intended installation.

F. Maximum pressure drop: 0.10 in. wg; provide ductwork transitions as required so as not to exceed maximum pressure drop.

G. Fire Resistance Rating: 1 hour.

H. Leakage Rating: Class 1 (maximum of 8 cfm/ft^2 at 4 in. wg) unless noted otherwise.

I. Elevated Temperature Rating: 250°F (121°C) for 30 minutes. For smoke control systems provide provide dampers rated for 350°F (177°C) for 30 minutes.

J. Airflow Closure Rating:

1. Dynamic fire/smoke dampers shall be selected for the velocity and pressure rating of the intended installation. Refer to the plans and schedules for airflow rates (CFM) and pressures (in. wg).
2. Dampers shall have a minimum velocity rating of 2000 fpm at a pressure rating of 4 in. wg.

K. Types:

1. Round: for use in systems up to 3000 fpm velocity.
   a. Construction:
      1) Frame: Galvanized steel (in gauges required by manufacturer's UL listing).
      2) Blade design: single galvanized steel blade (in gauge required by manufacturer's UL listing).
      3) Retainer plate(s): supplied with damper.
      4) Sleeves: Length as required per wall thickness.
      5) Duct Transition Connection: breakaway type.
2. Multi-blade:
   a. Up to 2000 fpm velocity: Triple vee-groove type blade.
   b. 2000-4000 fpm velocity: Fabricated double skin airfoil type blade.
   c. Construction:
      1) Frame: Galvanized steel with mitered and interlocking corners (in gauges required by manufacturer's UL listing).
      2) Blade design: 16 ga. galvanized steel strengthened by three longitudinal 1" deep Vee grooves running the entire length of each blade. Each blade shall be symmetrical relative to its axle pivot point, presenting identical performance characteristics with air flowing in either direction through the damper. Provide symmetrical blades of varying size as required to completely fill the damper opening.
      3) Blade Stops: Each blade stop (at top and bottom of damper frame) shall occupy no more than ½" of the damper opening area to allow for maximum free area and to minimize pressure loss across the damper.
      4) Seals:
         a) Blade Edge: Blade seals shall be extruded silicone rubber permanently bonded to the appropriate blade edges.
         b) Jamb: Flexible stainless-steel compression type.
      5) Linkage: Concealed in jamb.
      6) Axles: Minimum ½" diameter plated steel.
      7) Bearings: Axle bearings shall be sintered bronze sleeve type rotating in polished extruded holes in the damper frame.
      8) Sleeves: Damper shall be supplied as a single assembly with a factory sleeve.
      9) Retaining Angles: Damper shall be supplied with factory retaining angles sized to provide installation overlap in accordance with the manufacturer's UL listing.
      10) Duct Transition Connection: breakaway type

L. Heat Responsive Device: Electric, controlled closure, quick detect heat-actuated device designed to prevent damage to ductwork and other HVAC system components. The device shall be a reusable/resettable link (RRL) with a temperature setting of 165°F (74°C).

M. No Flow Smoke Detector (if indicated on the drawings): rated for air velocities from 0 to 3000 fpm; UL268A listed, factory mounted internally on the damper sleeve with built-in test switch.

N. Photoelectric [ionization] Type Smoke Detector (if indicated on the drawings): rated for air velocities from 300 [100] to 4000 fpm; UL268A listed, factory mounted internally on the damper sleeve.

O. Damper Motors: Two-position meeting the following:

1. Comply with NEMA designation, temperature rating, service factor, enclosure type, efficiency requirements and the following:
   a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so the driven load will not require motor to operate in service factor range above 1.0.

b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
c. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
d. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 150 in. x lbf (17 N x m).
e. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40°F (minus 40°C).
f. Nonspring-Return Motors: For dampers larger than 25 sq. ft. (2.3 sq. m), size motor for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 300 in. x lbf (34 N x m).
g. Electrical Connection: 115 V, single phase, 60 Hz.

2. Momentary Test Switch (for use in combination fire and smoke dampers that are not part of a smoke management system): factory mounted and wired assembly for testing and cycling the damper during start-up and maintenance. Power wiring to test switch and actuator shall be per manufacturer's installation instructions.

P. Corridor Combination Fire and Smoke Dampers shall have a single point wiring per UL requirements (except where two signals are required as with the Temperature Limited Override specified above).

2.8 SMOKE DAMPERS

A. Smoke dampers shall be installed at all locations where ductwork or supply or return air openings penetrate any floor, wall or partition with a smoke rating, or where otherwise shown on the drawings, except where such ductwork or openings are part of an engineered smoke removal system.

B. Smoke dampers shall be provided with factory installed actuators capable of closing the damper on activation of area smoke detectors, the fire alarm system and/or the Firefighter's Smoke Control Panel and shall be normally closed. Actuators shall be compatible with the activating smoke detectors or fire alarm system (coordinate with other trades).

1. For stair and elevator hoist-way pressurization fans, provide a Class 1, normally open smoke damper at the fan inlet for use as a control damper; Ruskin Model SD60, Pottorff Model SD-151 or equal.

C. Unless otherwise indicated, smoke detectors integral to the smoke damper shall be furnished and installed by the fire alarm contractor (coordinate with other trades).

D. All smoke dampers shall be tested and certified in accordance with UL Standard 555S.

E. Leakage Rating: Class 1 (maximum of 8 cfm/ft^2 at 4 in. wg) unless noted otherwise.

F. Elevated Temperature Rating: 350°F (177°C) for 30 minutes.

G. Airflow Closure Rating:

1. Dynamic smoke dampers shall be selected for the velocity and pressure rating of the intended installation. Refer to the plans and schedules for airflow rates (CFM) and pressures (in. wg).
2. Dampers shall have a minimum velocity rating of 2000 fpm at a pressure rating of 4 in. wg.
3. Dampers in systems operating above 2000 fpm or 4 in. wg shall be selected for a velocity rating of 4000 fpm at a pressure rating of 6 in. wg.

H. Types:

1. Round: for use in systems up to 3000 fpm velocity.
   a. Construction:
      1) Frame: Galvanized steel (in gauges required by manufacturer's UL listing).
      2) Blade design: single double skin galvanized steel blade (in gauge required by manufacturer's UL listing).
      3) Retainer plate(s): supplied with damper.
      4) Sleeves: Length as required per wall thickness.
      5) Duct Transition Connection: breakaway type.
2. Multi-blade:
   a. Up to 2000 fpm velocity: Triple Vee-groove type blade.
   b. 2000-4000 fpm velocity: Fabricated double skin airfoil type blade.
   c. Construction:
      1) Frame: Galvanized steel with mitered and interlocking corners (in gauges required by manufacturer's UL listing).
      2) Blade design: Galvanized steel strengthened longitudinal Vee grooves running the entire length of each blade.
      3) Blade Stops: Each blade stop (at top and bottom of damper frame) shall occupy the minimum damper opening area required by manufacturer's UL listing to allow for maximum free area and to minimize pressure loss across the damper.
      4) Seals:
         a) Blade Edge: Blade seals shall be extruded silicone rubber permanently bonded to the appropriate blade edges.
         b) Jamb: Flexible stainless-steel compression type.
      5) Linkage: Concealed in jamb.
      6) Axles: Minimum ½" diameter plated steel.
      7) Bearings: Axle bearings shall be sintered bronze sleeve type or stainless-steel rotating in polished extruded holes in the damper frame.
      8) Sleeves: Damper shall be supplied as a single assembly with a factory sleeve.
      9) Retaining Angles: Damper shall be supplied with factory retaining angles sized to provide installation overlap in accordance with the manufacturer's UL listing where required.
      10) Duct Transition Connection: breakaway type

I. No Flow Smoke Detector (if indicated on the drawings): rated for air velocities from 0 to 3000 fpm; UL268A listed, factory mounted internally on the damper sleeve with built-in test switch.

J. Photoelectric [ionization] Type Smoke Detector (if indicated on the drawings): rated for air velocities from 300 [100] to 4000 fpm; UL268A listed, factory mounted internally on the damper sleeve.

K. Damper Motors: Two-position meeting the following:

1. Comply with NEMA designation, temperature rating, service factor, enclosure type, efficiency requirements and the following:
   a. Motor Sizes: Minimum size as required by manufacturer's UL listing.
   b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
   c. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40°F (minus 40°C).
   d. Electrical Connection: 115 V, single phase, 60 Hz.

2. Momentary Test Switch (for use in smoke dampers that are not part of a smoke management system): factory mounted and wired assembly for testing and cycling the damper during start-up and maintenance. Power wiring to test switch and actuator shall be per manufacturer's installation instructions.

L. Smoke Dampers shall have a single point wiring per UL requirements.

2.9 CONTROL DAMPERS

A. Automatic control dampers shall be installed as shown on the drawings and shall be controlled as described in the 23 09 00 - Automatic Controls section of these specifications.

B. Unless indicated otherwise, dampers shall be of the opposed blade type constructed of minimum 18-gauge galvanized steel and shall have rigidly constructed blades less than 6" wide and shall have duct mounting flanges.

C. Dampers shall be the low leakage type with replaceable blade and jamb seals. Maximum pressure drop for dampers operating in systems exceeding 2000 fpm shall be 0.10 in. wg.

D. Outside air supply and exhaust openings shall be provided with a Class 1 motorized damper with a maximum leakage rate of 4 cfm/ft^2 (20.3 L/s · m^2) at 1.0 in. wg (249 Pa) when tested in accordance with AMCA 500D.

1. Gravity (non-motorized) dampers having a maximum leakage rate of 20 cfm/ft^2 (101.6 L/s · m^2) at 1.0 in. wg (249 Pa) when tested in accordance with AMCA 500D may be used in any one of the following conditions:
   a. In buildings for exhaust and relief dampers.
   b. In buildings of less than three stories in height above grade.
   c. For ventilation air intakes and exhaust and relief dampers in buildings of any height in Climate Zones 1, 2 and 3.
   d. Where the design outdoor air intake or exhaust capacity does not exceed 300 cfm (141 L/s).

   Gravity (non-motorized) dampers for ventilation air intakes shall be protected from direct exposure to wind.
2. Dampers smaller than 24 inches (610 mm) in either dimension shall be permitted to have a leakage rate of 40 cfm/ft2 (203.2 L/s · m2) at 1.0 in. wg (249 Pa) when tested in accordance with AMCA 500D.

2.10 REMOTE DAMPER OPERATORS

A. Cable operated type:

1. Manufacturers: Subject to compliance with all requirements: Pottorff, Ventfabrics, Inc., Duro Dyne or Young Regulator Company.
2. Description: Cable system designed for remote manual damper adjustment.
3. Cable: Stainless steel with flexible steel casing or steel with synthetic casing.
4. Control: Concealed regulator kit with steel locking rack and pinion gear with hex head adjustment or damper control is via push-pull lever action.
5. Linear slot diffuser: Pottorff Models RCS-10 (rectangular) or RCS-10R (round) or Young Regulator Model 270-275ML plenum mounted cable controller with 5020CC (round) or 830AC (rectangular) balancing damper.
6. Wall-Box Mounting: Recessed
7. Wall-Box Cover-Plate Material: Steel \

B. Electronic type:

1. Manufacturers: Subject to compliance with all requirements: Ventfabrics, Inc., Duro Dyne, Pottorff, or Young Regulator Company.
2. Description: System designed for remote electronic damper adjustment.
3. Cable: plenum rated with 5 conductors
4. Control: 9V DC or 12V DC actuator, <0.5 watts
5. Wall mounting kit with recessed wall box and cover plate.
6. Ceiling mounting kit with recessed box and cover plate.
7. Controller: battery powered handheld with LCD damper position indicator (one per project).

C. Install in strict conformance with manufacturer's installation instructions.

2.11 FLEXIBLE DUCT CONNECTORS

A. Install flexible duct connectors at connections of sheet metal duct to motor driven equipment, in ductwork crossing building expansion joints, or otherwise noted. Install per manufacturer's instructions, and support sheet metal ductwork so that no weight is supported by the flexible duct connector.

B. Basis-of-Design Product unless noted otherwise below: Subject to compliance with requirements, provide Ductmate Industries, Inc.; PROflex or comparable product by one of the following:
1. Duro Dyne Inc.
2. Ventfabrics, Inc
3. Prior Approved Equal

C. Materials: Flame-retardant or noncombustible fabrics compliant with NFPA 701.

D. Coatings and Adhesives: Comply with UL 181, Class 1 and have a maximum flame spread/smoke developed rating of 25/50.

E. Metal-Edged Connectors: Factory fabricated with a fabric strip 5¾-inches wide attached to two strips of 2¾-inch wide, 0.028-inch thick, galvanized sheet steel. Provide metal compatible with connected ducts.

F. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd.
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200ºF.

G. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd.
2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: Minus 50 to plus 250ºF.

H. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of ¼-inch movement at start and stop.

2.12 ACCESS DOORS

A. Hinged, gasketed and latched Access Doors (AD) and/or panels shall be installed at each fire and smoke damper, each duct mounted smoke detector, each valve, at each duct mounted balancing damper or any other mechanical equipment or device that requires accessibility. Doors and panels shall be sized (minimum 18" x 18", duct size allowing), and located to optimize access to dampers, detectors, and other equipment for service and replacement. Access Panels (AP) in walls, ceilings or other surfaces shall be coordinated with architectural finishes and selected by the architect.

B. Access doors shall be designed for five times the pressure of the duct in which it is mounted.

C. Access doors for fire dampers, combination fire/smoke dampers and smoke dampers in medium pressure (+4 in.wg and higher) duct systems shall be the implosion type designed to prevent excessive negative pressure downstream resulting in collapsed ductwork. At the contractor's option, the access door may be an integral feature of the damper assembly.

D. Access doors for grease exhaust ducts shall be in accordance with NFPA 96 (latest edition). Vertical grease ducts shall have an access door at each floor level in an inconspicuous location.

E. Access doors for fire dampers, combination fire/smoke dampers and smoke dampers shall be permanently identified by a die-cut label with ½" high red block letters on a white background. Label shall read FIRE DAMPER, COMBINATION FIRE/SMOKE DAMPER or SMOKE DAMPER.

F. Duct-Mounted Access Doors: Fabricate access panels per SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2 (7-2M), "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct".

1. Basis-of-Design Product: Subject to compliance with requirements, provide Ductmate Industries, Inc.; Access Doors or comparable product by one of the following:
   a. American Warming and Ventilating; a division of Mestek, Inc.
   b. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
   c. Prior Approved Equal
2. Door:
   a. Double wall, rectangular.
   b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
   c. Vision Panel:
      1) Observation type doors shall be sandwich type provided at all fire and smoke dampers, humidifiers, in-duct smoke detectors, and UVC emitters.
      2) Minimum 12"x12" with 8"x8" viewport, insulated or non-insulated.

3) For ducts smaller than 12-inches, 10"x6" shall be used with a 4"x 2-5/8" viewport with a single pane of safety glass.

d. Hinges and Latches: 1"x1" butt or piano hinge with cam latches.

e. Fabricate doors airtight and suitable for duct pressure class.

3. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

4. Number of Hinges and Locks:

a. Access Doors Less Than 12 inches Square: No hinges and two sash locks.

b. Access Doors up to 18 inches Square: Continuous hinge and two sash locks.

c. Access Doors up to 24 by 48 inches: Continuous hinge and two compression latches.

d. Access Doors Larger Than 24 by 48 inches: Continuous hinge and two compression latches.

G. Pressure Relief Access Door:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. American Warming and Ventilating; a division of Mestek, Inc.

b. Cesco Products; a division of Mestek, Inc.

c. Elgen Manufacturing

d. Flexmaster U.S.A., Inc.

e. Greenheck Fan Corporation

f. McGill AirFlow LLC

g. Nailor Industries Inc.

h. Pottorf

i. Ventfabrics, Inc.

j. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

k. Prior Approved Equal

2. Door and Frame Material: Galvanized sheet steel.

3. Door: Single or Double wall with insulation fill, as required, with metal thickness applicable for duct pressure class.

4. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.

5. Factory set at 3.0- to 8.0-in. wg.

6. Doors close when pressures are within set-point range.

7. Hinge: Continuous piano

8. Latches: Cam

9. Seal: Neoprene or foam rubber

10. Insulation Fill: 1" thick, fibrous-glass or polystyrene-foam board.

H. Duct Access Panel Assemblies:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Ductmate Industries, Inc.; Ultimate Door or comparable product by one of the following:

a. Flame Gard, Inc.

b. Prior Approved Equal

2. UL 1978 listed by an NRTL

3. Panel and Frame: Minimum thickness 0.0528-inch carbonsteel.

4. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.

5. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000ºF.

6. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.13 DUCT LINER

A. Also refer to Section 23 07 00 - HVAC Insulation.

B. Supply air ductwork a minimum of 15 linear feet downstream and return air ductwork a minimum of 15 linear feet upstream of low-pressure air handling equipment and terminal units shall be internally lined with 1½" thick acoustical duct liner/insulation (minimum R-6 or greater where required by code),; Johns Manville Linacoustic RC or approved equal.

1. Duct liner shall be securely fastened to ductwork with stick pins, speed washers and adhesive.
2. Leading edges of liner shall have a sheet metal nosing.
3. Exposed edges and butt joints shall be “buttered” with duct sealer.
4. Duct liner shall be interrupted at all fire, smoke, combination fire/smoke and radiation dampers.
5. Duct liner shall be interrupted not less than 6" upstream and 6" downstream of electric-resistance and fuel-burning heaters in a duct system.

C. Return air ductwork, sound boots and transfer ducts shall have 1" thick liner, Johns Manville Linacoustic RC or approved equal.

1. Refer to Section 23 07 00 - HVAC INSULATION for return air ductwork requiring external insulation.

D. Subject to compliance with requirements, duct liner products shall be manufactured by: CertainTeed, Johns Manville, Knauf, Owens Corning, Manson Industries, or approved equal.

PART 3 – EXECUTION

3.1 INSTALLATION

A. All ductwork shall be installed in accordance with applicable SMACNA Standards according to the pressure class described in PART 1 - GENERAL.

B. Seal, inspect and test ductwork prior to insulating or concealing. Seal all ductwork and plenums to meet the following SMACNA duct seal class:

1. Class A: Seal all transverse joint, longitudinal seams, and duct wall penetrations.
   a. Pressure-sensitive tape shall not be used as the primary sealant, unless it has been certified to comply with UL 181A or UL 181B by an independent testing laboratory and the tape is used in accordance with that certification.
   b. All connections shall be sealed, including but not limited to spin-in fittings, taps, other branch connections, access doors, and duct connections to equipment.
   c. Sealing that would void product listings is not required.
   d. Spiral lock seams need not be sealed.
2. Tapes, sealants and mastics used to seal metallic and flexible air ducts and flexible air connectors shall comply with UL 181B and shall be marked “181B-FX” for pressure-sensitive tape or “181B-M” for mastic/sealant.
3. Mechanical fasteners for use with flexible nonmetallic air ducts shall comply with UL 181B and shall be marked “181B-C”.

C. Seal the annular space around all duct, grilles, registers, diffusers, etc. penetrations through walls, floors, and ceilings airtight with an approved material. Refer to the Architectural documents for approved materials.

D. Sheet metal and flexible ductwork shall be supported as recommended by SMACNA Standards from structural members. Zip ties are not an acceptable method for suspending ductwork. Ductwork shall not be allowed to rest on ceilings, light fixtures or structural members. Ductwork supported from joists shall be supported from the top chord of all joists.

E. All ductwork accessories shall be installed in strict accordance with manufacturer's recommendations.

F. Ductwork that is designed to operate at static pressures in excess of 3 in. wg and all ductwork located outdoors shall be leak-tested in accordance with SMACNA Standards. Representative sections totaling no less than 25% of the total installed duct area for the designated pressure class shall be tested. All sections shall be selected by the building owner or the designated representative of the building owner. Positive pressure leakage testing is acceptable for negative pressure ductwork. The maximum permitted duct leakage shall be:

$$L_{max} = C_L P^{0.65}$$

where

L_{max} = maximum permitted leakage, cfm per100 ft^2 of duct surface area
C_L = 4, duct leakage class, cfm per100 ft^2 of duct surface area per inch of $water^{0.65}$
P = test pressure, which shall be equal to the design duct pressure class rating, in. of water

All ductwork seams shall be sealed with mastic to provide a system that is within the recommended SMACNA leakage limits. As an alternate, water-based spray-on hardcast products may be used provided they meet or exceed the project requirements.

The ductwork test report shall be submitted in electronic (PDF) format to the Engineer prior to the Contractor's request for final payment.

G. All ductwork shall be cleaned inside and out prior to system start up and shall be left in a neat and orderly manner.

H. Duct sizes shown on drawings are inside clear dimensions.

I. Unless otherwise approved, ducts shall be true to dimensions indicated, straight and smooth on the inside with neatly finished joints, securely anchored to the building in an approved manner, and installed to be completely free from vibration under all conditions of operation. Exact routing of ductwork will be dependent on location of framing members. Route ductwork to avoid cutting framing members.

J. Brace ducts not more than 60 inches on center.

K. Make slip joints in the direction of air flow.

L. Offset ducts around obstructions where possible. Where duct must encompass obstruction, area of duct shall remain constant.

M. Duct tapers shall not exceed 1:4 ratio and transformations 30 degrees between air flow and diverging or converging air flow.

N. Provide access doors for access to all equipment, dampers and motors concealed by sheet metal.

O. Where applicable, provide seismic bracing and restraints for ductwork per ASCE/SEI 7, latest edition and the latest edition of the SMACNA Seismic Restraint Manual. Also, refer to Section 23 05 48 Noise and Vibration Control.

P. Duct liner shall be installed in accordance with manufacturer's instructions, the latest edition of AH124 North American Insulation Manufacturers Association Fibrous Glass Duct Liner Standard (NAIMA FGDLS) or Sheet Metal and Air Conditioning Contractors National Association HVAC Duct Construction Standard, Metal & Flexible (SMACNA HVAC DCS).

Q. Mechanical, Electrical, Plumbing, and other controls shall not be installed in ductwork or through dampers.

3.2 BALANCING DAMPERS

A. Install manual volume dampers where indicated on the drawings and where required to properly balance the air distribution system.

B. Provide an opposed blade damper behind the face of each supply register which shall be adjustable through the face of the register with a screwdriver.

C. Provide an opposed blade damper behind the face of return air registers, where indicated, which shall be adjustable through the face of the register with a screwdriver.

D. Provide a butterfly damper in the neck of each ceiling diffuser unless noted otherwise.

END OF SECTION

SECTION 23 34 00

UNITARY EXHAUST AND SUPPLY FANS AND VENTILATORS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Refer to specification section 23 00 00 - HVAC General, all of which applies to work described in this section as if written in full herein. Special attention should be given to Section 2.02 ELECTRICAL WORK for specifics on motor and drive requirements.

B. Furnish and install all unitary exhaust and supply fans and ventilators of the size, type, capacity and characteristics as shown on the equipment schedules and herein described.

C. Base fan-performance ratings on actual project site altitude.

D. Acceptable manufacturers include only those whose products have been in satisfactory use in similar service for not less than five (5) years.

E. Electrical Standards: Provide electrical motors and products which have been listed and labeled by Underwriters Laboratories Inc. and comply with NEMA Standards.

F. Certification, Fan Performance: Fans shall be certified to bear the AMCA label for air and sound performance.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL AND AXIAL FANS AND VENTILATORS

A. All units shall be rigidly constructed of materials suitable for the intended service and shall be installed with all accessories listed on the Drawings.

B. All roof mounted units shall be installed on factory supplied 14-inch high (minimum) insulated roof curbs of the proper type, size and construction for proper mounting. Curbs shall account for all roof slopes and pitches so that the unit is installed level. Units shall be anchored to curbs by a minimum of two lag screws of adequate size on each side. Curbs shall be constructed of galvanized steel, except when the project is located within 5 miles of a sea coast they shall be of aluminum construction.

C. Outdoor fans shall be completely weatherproof for outdoor installation and shall contain internal vibration isolation to assure smooth and quiet performance.

D. Fan wheels and blades shall be constructed of aluminum and shall be statically and dynamically balanced at the factory.

2.2 CEILING-CENTRIFUGAL AND CABINET FANS

A. Units shall be direct-drive type with back-draft damper, acoustically insulated cabinets and speed controller.

PART 3 - EXECUTION

3.1 GENERAL

A. All units shall be installed in accordance with manufacturer's recommendations and as shown on the Drawings.

B. Ceiling-centrifugal and cabinet fans shall be supported from structural members and shall not rest on the ceiling, on lights or on structural members.

C. Units shall be interlocked and controlled as indicated on the Drawings.

D. Ceiling-mounted units shall be installed with ceiling grilles flush with the ceiling.

E. Curb-mounted fans shall be secured to the roof curb with lag screws in each hole in the fan curb cap.

F. Electrical connection to the fan motor shall be made through the roof opening inside the roof curb.

G. Replace fan and motor pulleys as required to achieve design airflow.

END OF SECTION

SECTION 23 37 00

LOUVERS, GRILLES, REGISTERS AND DIFFUSERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. All work in this section shall be subject to the provisions of Section 23 00 00 - HVAC General.

B. Furnish and install all louvers, grilles, registers and diffusers of the size, type, capacity, and characteristics as shown on the equipment schedules and specified herein.

C. Equipment schedules and specifications are intended to establish a minimum level of quality and workmanship for the project. When other than the basis of design equipment is proposed, the Contractor shall be responsible for all costs associated with engineering and construction modifications necessary in his or any other trade that may be required to satisfy the Contract Documents.

D. Refer to the drawings for basis of design manufacturer and acceptable alternates.

PART 2 - PRODUCTS

2.1 LOUVERS

A. Louver components (heads, jambs, sills, blades, etc.) shall be factory assembled by the manufacturer into a complete unit. Louver sizes too large for shipping shall be built-up from factory assembled louver sections to provide the overall sizes required.

B. Louver design shall incorporate structural supports required to withstand a wind load of 20 lbs./square foot.

C. All louver performance data submitted for approval shall bear the AMCA Certified Ratings Seal for Air Performance and Water Penetration.

D. All louvers shall have a factory applied finish coating as scheduled with the color selection made by the Architect at the time of shop drawing approval. Color charts shall be submitted with louver shop drawings.

E. Screens:

1. General: Provide a screen at each exterior louver.
2. Frames: Same kind and form of metal as indicated for louver to which screens are attached.
3. Screening material:
   a. Bird Screen: Aluminum, ¼" by ¼" square mesh wire; 0.047" thick

2.2 GRILLES, REGISTERS AND DIFFUSERS

A. Units shall be of the type, size, and construction as scheduled or indicated.

B. Unless otherwise noted or indicated, all air devices shall be supplied with a factory finish of manufacturer's standard white.

C. Grilles, registers and diffusers shall be ordered with borders compatible with the ceiling system type in which they are installed. Refer to architectural drawings for type of ceiling and/or suspension system.

D. Aluminum air devices shall be used for all areas subject to excessive moisture or humidity (e.g. showers, pools, bathrooms, etc.).

PART 3 - EXECUTION

3.1 LOUVERS

A. Louvers shall be installed in accordance with the manufacturer's recommendations.

B. The louver installation shall be made weatherproof by caulking and sealing at the frame and flanges in accordance with the manufacturer's recommendations.

C. Combination louver/dampers shall be installed with the required actuators and linkage mechanisms and shall be field adjusted for full opening/closure stroke. Louvers shall be interlocked as scheduled or indicated.

3.2 GRILLES, REGISTERS AND DIFFUSERS

A. All air devices located in ceiling tiles shall be centered or shall be on quarter points of 2 ft. x 2 ft. tiles.

B. Where a line of sight allows the ductwork, wall, or ceiling structure to be seen behind any units, such ductwork, wall or ceiling structure shall be painted with nonflammable flat black paint to minimize visibility.

C. All air devices not installed on T-bar ceiling grids shall be securely fastened to adjacent structures.

D. Where air distribution devices are installed in inaccessible ceilings, provide the spin-in fitting without a volume damper. Provide an opposed blade damper in the neck of the air distribution device with access to the damper control through or at the face of the device.

END OF SECTION

SECTION 23 74 02

SINGLE PACKAGE ROOFTOP HEAT PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION

A. All work in this section shall be subject to the provisions of Section 23 00 00 - HVAC General.

B. Furnish and install factory assembled, piped and wired single package rooftop heat pumps of the type, operational characteristics and capacity as shown and scheduled and as specified herein. All rooftop units shall be by the same manufacturer. The manufacturer shall have available factory trained service engineers and an inventory of replacement parts within a 100-mile radius of the job site.

C. Refer to the drawings for basis of design manufacturer and acceptable alternates.

D. Compressor shall be warranted against parts failure for five (5) years.

E. Submit catalog cuts, certified performance data, and dimensional data.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

A. Unit shall be designed specifically for outdoor installation with all exterior surfaces of phosphatized, zinc-coated steel with primer and baked enamel finish. All components, including accessories shall be contained within the unit.

B. Access to internal components shall be afforded by removable gasketed access panels with quick release latches and lifting handles.

C. Unit shall have factory installed lifting lugs capable of accepting standard lifting slings and spreader bars to facilitate hoisting.

D. Electrical power connections shall be to a single point.

E. Unit shall be insulated with a minimum of ½" thick, 1½ lb./ft^3 density fiberglass insulation. Insulation shall have a microbial resistant neoprene coating.

F. Unit shall be designed for curb mounting and mate with a full perimeter roof curb for a complete weather tight seal. Curb shall be a minimum of 14" high and manufactured of 12-gauge zinc-coated steel and be supplied by the unit manufacturer with wood nailer strip and full perimeter gasket. Unit sides shall overhang the curb to form protective drip lip. Supply and return ducts shall connect to the curb prior to placement of the unit. The manufacturer shall furnish gasketing material for a leak-tight seal between the unit and duct connections.

2.2 HEATING SECTION

A. If scheduled, provide an open wire electric heating coil with thermal high limit cut-outs and over current protection. Units with electric heat shall have a single point power connection.

2.3 COMPRESSOR

A. Fully hermetic scroll or rotary compressor(s) shall be provided with capacity reduction of a minimum of 50% on units 7½ tons and larger.

B. A crankcase heater shall be provided and wired to be active continuously.

C. The compressor shall be provided with spring isolators and flexible discharge line and hot gas muffler.

D. Motor shall be specifically designed for operation within a refrigeration atmosphere. Inlet screens shall be provided. Motor shall be capable of starting and continuously operating at ambient temperatures as high as 120ºF. Motor shall have overload protection and internal thermostats.

E. Compressor motor shall be capable of withstanding voltage fluctuations of plus or minus 10% of name plate voltage.

2.4 REFRIGERANT CIRCUIT

A. The unit shall be certified as complying with AHRI Standard 210/240 or 340/360 and bear the AHRI seal.

B. The indoor coil shall be constructed of 3/8" O.D. copper tubes mechanically bonded to aluminum plate fins and be pressure and leak tested at 425 psig. Outdoor fans shall be statically and dynamically balanced. Fan motors shall be UL Listed for outdoor use, have built-in thermal overload protection and permanently lubricated bearings. Condensing section shall be designed for a maximum of 130ºF condensing temperature with ambient air at 95ºF. Coil shall be circuited for sub-cooling.

C. Unit shall incorporate an insulated and sealed IAQ drain pan with threaded drain connections at each end of the unit. The Contractor shall install P-traps. Overflow protection shall be provided via a float switch wired to shut the unit off if liquid is detected.

D. Refrigeration controls shall include as a minimum, high and low pressure control, compressor winding thermostat and overload, lockout circuit re-settable at the unit thermostat, contactors for condenser/evaporator fans and compressor, 24 volt control power transformer, reversing valve, defrost cycle and emergency heat.

E. Unit shall ship with an operating charge of refrigerant.

2.5 INDOOR FANS

A. Indoor fans shall be direct driven or belt driven forward curved type with an adjustable sheave and motor sized to meet the air flow and static pressure as scheduled.

B. Fan assembly shall be isolated from the unit on rubber-in-shear or spring type isolators.

C. Motor shall have thermal overload protection and motor and fan bearings shall be permanently lubricated.

D. Fan wheel shall be protected from corrosion with a painted finish.

2.6 FILTERS

A. Two (2) sets off filters shall be provided; 2-inch thick, pleated fiberglass, disposable type with an ASHRAE efficiency of 30% (MERV 8).

B. Only one size filter per unit is allowed.

C. During construction, the initial set of filters will be installed along with temporary media consisting of two plys of polyester fibers; 1¼" (32mm) thick with a non-migrating tackified surface having a MERV 8 rating.

1. For non-ducted (plenum return) systems, use roll filter media over each inlet duct.
2. For ducted systems, use precut pads with holding frames installed at each return air register or grille.

2.7 ACCESSORIES TO BE PROVIDED

A. Accessories noted below may or may not be required for equipment scheduled. Refer to the equipment schedules on the drawings for specific accessory requirements.

B. 7-day programmable thermostat with clear plastic locking cover.

C. Thermostat sub-base with fan ON-AUTO and HEAT-OFF-COOL control.

D. Programmable/Lockable Averaging Thermostat/Humidistat with Interlocked Temperature/Humidity Sensor.

E. Non-fused disconnect switch.

F. Low leakage dampers.

G. Outside air intake hood with inlet screen.

H. Manual outside air volume damper.

I. Anti-cycling timer to provide 5-minute delay between compressor shut-down and restart.

J. Head pressure controls to allow compressor operation to -20°F.

K. Roof curb. Coordinate with the roof system used so that a minimum of 8" of the curb is above the finished roof for flashing purposes. The top of the curb shall be level and the slope of the roof shall be compensated for by the curb.

L. DDC system communicating controller.

M. Hail Guards.

N. Phase Monitor (3 phase units only)

PART 3 - EXECUTION

3.1 EQUIPMENT

A. Unit shall be shipped with a full refrigerant charge.

B. Unit shall be run tested at factory before shipping.

3.2 INSTALLATION

A. Unit to be installed level with manufacturer’s recommendations.

B. The second set of filters shall be installed after testing and balancing has been completed.

END OF SECTION

SECTION 23 81 28

SPLIT SYSTEM HEAT PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION

A. All work specified herein shall be accomplished in accordance with the applicable requirements of Section 23 00 00 - HVAC General.

B. Furnish and install a direct expansion air-to-air heat pump unit of the size and capacity shown on the equipment schedule. The unit shall be completely factory assembled and tested, and shall include compressor, indoor and outdoor coils, stand-by electric strip heating coils, fan motors as required, pre-wired controls, interconnecting refrigerant tubing, wiring, and circuit breakers. Condensing unit shall be factory matched with evaporator coils and air handling unit; units shall be rated in accordance with AHRI and UL Listed.

C. Equipment schedules and specifications are intended to establish a minimum level of quality and workmanship for the project. When other than the basis of design equipment is proposed, the Contractor shall be responsible for all costs associated with engineering and construction modifications necessary in his or any other trade that may be required to satisfy the Contract Documents.

D. Refer to the drawings for basis of design manufacturer and acceptable alternates.

1.2 RELATED DOCUMENTS

A. For piping, valves, accessories and piping insulation refer to Section 23 23 00 – Refrigerant Piping.

PART 2 - PRODUCTS

2.1 GENERAL

A. Each unit shall be a complete and factory package consisting of compressor, condenser coil, stand-by electric heating coil, condenser fans and motors, refrigeration and temperature controls, Unit shall have a certified AHRI rating.

2.2 AIR HANDLER

A. The cabinet shall be complete and constructed of minimum 20-gauge galvanized steel zinc coated and shall be painted with a baked-on powder coating finish. Interior surface of the cabinet shall be lined with a flexible acoustical and thermal insulation and shall be fireproof. Thickness of insulation shall be 1-1/2". Access to fan motor, filters, coils, controls and power supply shall be through the front panel of the unit.

B. The nonferrous direct expansion cooling coil shall be factory mounted and charged with refrigerant. Provide reversing valve, expansion valve, solenoid valve and complete refrigeration circuit. Provide insulated drain pan with exterior primary and secondary drain connection.

C. The air handling unit shall accept a 1" thick high velocity air filter, mounted internally and located upstream of the cooling coil.

D. The blower section shall have an adjustable V-belt or direct drive fan motor with a forward-curved centrifugal type blower mounted on vibration isolators. The fan motor shall have thermal overloads and be permanently lubricated. Direct drive fan motors shall have at least three (3) speeds.

E. An electric resistance heater shall supplement the heat pump operation.

F. The unit shall be supplied with a single point power connection.

2.3 OUTDOOR UNIT

A. The cabinet shall be constructed of galvanized steel with a baked-on enamel finish. Provide with removable access panel at one side of unit to access the compressor, coil, controls, and power supply. Drain holes shall be provided at the base of the unit. Provide fan and coil guards.

B. The compressor shall be the hermetic scroll or rotary type, furnished with complete refrigeration circuit(s) including nonferrous condenser coil, receiver, charging valve, refrigerant holding charge, external service valves, compressor anti-cycle protection, internal temperature and current-sensing overloads, crankcase heater, filter drier, evaporator freeze stat, liquid line solenoid valve, and vibration isolation. Controls shall include over and under voltage protection, high pressure cutout with auto-reset, motor starters and contactors. Compressor shall have a five-year warranty.

C. The fan motor shall be permanently lubricated with built-in thermal overload protection.

D. Install unit level as indicated on the Drawings.

E. The unit shall be supplied with a single point power connection.

2.4 CONTROLS

A. Unless noted otherwise, provide a seven-day programmable thermostat with manual changeover.

B. The thermostat shall prevent the auxiliary electric heat from being energized whenever the heating load can be met by the heat pump.

PART 3 - EXECUTION

3.1 GENERAL

A. Units shall be installed as shown on the Drawings and in strict accordance with manufacturer’s recommendations.

B. Units shall be installed level.

C. Units shall be installed to allow adequate service to all components.

END OF SECTION

SECTION 23 81 28.12

DUCTLESS COOLING ONLY SPLIT SYSTEMS (1 to 3½ TONS)

PART 1 - GENERAL

1.1 DESCRIPTION

A. All work specified herein shall be accomplished in accordance with the applicable requirements of Section 23 00 00 - HVAC General.

B. Furnish and install direct expansion air-to-air split system cooling only units of the size and capacity shown on the equipment schedule. The unit shall be completely factory assembled and tested, and shall include variable speed compressor, indoor and outdoor coils, fan motors, wireless or wired remote controller, interconnecting refrigerant tubing, and power and control wiring. The outdoor unit shall be of the inverter driven design and factory matched with the indoor unit.

C. Equipment schedules and specifications are intended to establish a minimum level of quality and workmanship for the project. When other than the basis of design equipment is proposed, the Contractor shall be responsible for all costs associated with engineering and construction modifications necessary in his or any other trade that may be required to satisfy the Contract Documents.

D. Refer to the drawings for basis of design manufacturer and acceptable alternates.

1.2 RELATED DOCUMENTS

A. For piping, valves, accessories and piping insulation refer to Section 23 23 00 – Refrigerant Piping.

1.3 QUALITY ASSURANCE

A. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL) and shall bear the ETL label.

B. All wiring shall be in accordance with the National Electrical Code (NEC).

C. The units shall be rated in accordance with Air-Conditioning, Heating, and Refrigeration Institute’s (AHRI) Standard 210/240 and bear the AHRI Certification label.

D. The units shall be manufactured in a facility registered to ISO 9001 and ISO 14001.

E. A dry air holding charge shall be provided in the indoor section.

F. System efficiency shall meet or exceed the scheduled values.

G. Delivery, Storage and Handling:

1. Equipment shall be stored and handled according to the manufacturer’s recommendations.
2. The controller shall be able to withstand a storage temperature of 105°F and 95% relative humidity without any adverse effects.

1.4 SUBMITTALS

A. Product Data: Include performance data (including extended capacity ratings if other than AHRI standard conditions are scheduled); installation, operation and maintenance manual; operating characteristics; furnished specialties; and accessories.

B. Submit AHRI Certificates.

1.5 COORDINATION

A. Coordinate size, weight and location with Architectural and Structural drawings. Where concrete pads are indicated, conform to Division 03 for concrete, reinforcement, and formwork requirements.

1.6 WARRANTY

A. The indoor and outdoor units shall carry a manufacturer's standard parts and defects warranty for a period five (5) years from the date of installation. The compressor shall carry a warranty of seven (7) years from the same date of installation. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer.

PART 2 - PRODUCTS

2.1 INDOOR UNITS

A. The indoor units shall be following types: wall mount. All indoor units shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, control circuit board, fan and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function after power interruption. Indoor unit shall be purged with dry air before shipment from factory.

B. Wall Mount Type:

1. Unit Cabinet:
   a. The cabinet shall be formed from high strength molded plastic with smooth finish, flat front panel design with access for filter. Cabinet color shall be white.
   b. A separate metal installation plate that secures the indoor unit firmly to the wall shall be furnished with the unit. The installation plate shall be securely attached to the wall using an appropriate anchoring method for the wall type the unit will be attached to.
2. Fan:
   a. The fan shall be a high performance direct drive double inlet forward curved sirocco type design driven by a single motor. The fan shall be statically and dynamically balanced and be powered by a motor with permanently lubricated bearings.
   b. The fan shall have three (3) speeds: Low, Mid, High and Auto. The fan shall have a selectable Auto fan setting that will adjust the fan speed based on the difference between controller set-point and space temperature.
3. Directional Air Flow Vane: An integral, motorized multi-position vane shall automatically direct air flow in a horizontal and downward direction to provide uniform air distribution.
4. Filter: Return air shall be filtered by means of an easily removable washable filter.
5. Coil:
   a. The indoor unit coil shall be of nonferrous construction with pre-coated aluminum strake fins on copper tubing. The multi-angled heat exchanger shall have a modified fin shape that reduces air resistance for a smoother, quieter airflow.
   b. All tube joints shall be brazed with PhosCopper or silver alloy.
   c. The coils shall be pressure tested at the factory.

d. A condensate pan and drain shall be provided under the coil.
e. Condensate overflow protection: a drain pan water level switch, designed to connect to the control board and shut the unit off, shall be provided when scheduled.
f. A condensate mini-pump shall be provided when scheduled to provide a means of condensate disposal when a gravity drain is not available.

2.2 OUTDOOR UNIT

A. General:

1. The outdoor unit shall be specifically designed and matched to operate with the indoor unit. The outdoor unit shall be completely factory assembled, piped and wired and run tested at the factory.
2. The outdoor unit shall be equipped with an electronic control board that interfaces with the indoor unit to perform all necessary operation functions.
3. The unit shall be capable of cooling operation down to 23°F (-5°C) ambient temperature without additional low ambient controls (an optional wind baffle shall be required for cooling operation down to 0°F (-17.7°C).
4. The outdoor unit shall be able to operate with a maximum height difference of 100 feet (30 meters) between the indoor and outdoor units.
5. System shall be capable of operation up to a maximum refrigerant tubing length of 100 feet (30 meters) for the 1 and 1½ ton units and 165 feet (50 meters) for the 2 thru 3½ ton units between indoor and outdoor units without the need for line size changes, traps or additional oil.

B. Unit Cabinet:

1. The casing shall be fabricated of galvanized steel finished with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection.
2. Serviceable parts shall be accessible by means of removable panel sections.
3. Cabinet color shall be the manufacturer's standard color.
4. The unit shall have two (2) mild steel mounting feet, transversely mounted and welded to the cabinet base pan. The mounting feet shall have a slotted mounting hole at each end for a total of four (4) mounting holes. The cabinet assembly shall be sufficient to withstand 155 MPH wind speed conditions for use in Hurricane condition areas.

C. Fan:

1. The unit shall be furnished with single or dual direct drive fan wheels.
2. The fan motor shall be a direct current (DC) motor with permanently lubricated bearings.
3. The fan motor shall be mounted for quiet operation.
4. The unit shall be provided with a raised fan safety guard to prevent contact with moving parts.
5. The outdoor unit shall have horizontal discharge airflow.

D. Coil:

1. The L shaped condenser coil shall be constructed of copper tubing with flat aluminum fins to reduce debris build up and allow maximum airflow. The coil shall be protected with an integral metal guard.
2. Refrigerant flow from the outdoor unit shall be regulated by means of an electronic linear expansion valve (LEV) metering device.
3. The outdoor unit shall be pre-charged with sufficient refrigerant to accommodate up to twenty-five (25) feet of refrigerant piping for capacities up to 18,000 btu/hr., and up to thirty-three (33) feet of refrigerant piping for capacities above 18,000 btu/hr.

4. Refrigerant linesets between the outdoor and indoor units shall be annealed refrigeration grade copper tubing, Type ACR, meeting ASTM B280 requirements. The lines shall be individually insulated in twin-tube, flexible, closed-cell, CFC-free (ozone depletion potential of zero), elastomeric material for the insulation of refrigerant pipes and tubes with a thermal conductivity equal to or better than 0.27 BTU-inch/hour per ft^2/°F and a water vapor transmission equal to or better than 0.08 Perm-inch. Insulation thickness shall be as required to satisfy project specific energy code requirements (refer to Section 23 23 00 Refrigerant Piping for additional information). Insulation shall have a Flame-Spread Index of less than 25 and a Smoke-development Index of less than 50 as tested by ASTM E 84 and CAN/ULC S-102.
5. Refrigerant piping connections between the outdoor and indoor units shall be flare type.

E. Compressor:

1. The compressor shall be the high performance, hermetic, inverter driven, variable speed, dual rotary type.
2. The compressor motor shall be the direct current (DC) type equipped with a factory installed inverter drive package.
3. The outdoor unit shall be equipped with an accumulator and high pressure safety switch.
4. The compressor shall be equipped with internal thermal overload protection.
5. To prevent liquid from accumulating in the compressor during the off cycle, a minimal amount of current shall be automatically, intermittently applied to the compressor motor windings to maintain sufficient heat to vaporize any refrigerant. No crankcase heater will be required.
6. There shall be no need for line size changes. Filters, sight glasses, and traps shall not be used, and no additional refrigerant oil shall be required.
7. The compressor shall be resiliently mounted to reduce vibration transmission.

F. Electrical:

1. The unit electrical characteristics shall be 208/230 volts, 1-phase, 60 hertz and shall be capable of satisfactory operation within voltage limits of 187 volts to 253 volts.
2. The outdoor unit shall be controlled by the microprocessor located in the indoor unit. The control signal between the indoor unit and the outdoor unit shall be pulse signal 24 volts DC. The unit shall have a Pulse Amplitude Modulation circuit to utilize 98% of the input power supply.

2.3 CONTROLS

A. General:

1. The system shall have either a wired remote controller as scheduled to perform input functions necessary to operate the system.
2. The controllers shall have a Power On/Off switch, Mode Selector – Auto, Cool, Dry Modes - Temperature Setting, Timer Control with Clock, Fan Speed Select and Vane / Airflow Direction selector. Controllers shall have a programmable Smart Set button for pre-selected Temperature, Fan Speed, and Vane position settings.
3. The controller shall support multiple languages (Spanish, German, Japanese, Chinese, English, Russian, Italian, or French) for display information.
4. The indoor unit shall be capable of performing self-diagnostic functions and check mode switching.
5. Temperature changes shall be displayed in 1ºF (1ºC) increments with a range of 61 - 88ºF (16-31ºC).

6. The microprocessor located in the indoor unit shall have the capability of sensing return air temperature and indoor coil temperature, receiving and processing commands from the wireless or a wired controller, providing emergency operation and controlling the outdoor unit.
7. The system shall be capable of automatically restarting and operating at the previously selected conditions when the power is restored after power interruption.
8. Control system shall control the continued operation of the air sweep louvers, as well as provide On/Off, System/Mode function.
9. Controller:
    a. Wired wall mounted remote controller: The wired remote controller shall be furnished with a communications interface to communicate with the indoor unit. The interface will be mounted at the indoor unit.
    The wired remote controller shall have a light-green LCD display. There shall be a built-in weekly timer with up to 8 pattern settings per day. The controller shall consist of an On/Off button, Increase/Decrease Set Temperature buttons, a Cool/Auto/Fan/Dry mode selector, a Timer Menu button, a Timer On/Off button, Set Time buttons, a Fan Speed selector, a Ventilation button, a Test Run button, and a Check Mode button. The controller shall have a built-in temperature sensor.

2.4 ACCESSORIES

A. Wind Guard/Baffle: if specified or if required to achieve proper operation due to high wind conditions and/or low ambient operation.

B. Wall mounting bracket (if specified): factory fabricated painted steel bracket to accept outdoor unit mounting holes, secure to wall and provide manufacturer recommended airflow and maintenance clearances.

C. Air outlet guide: provide where multiple units are arranged for series airflow at less than manufacturer’s recommended airflow clearance.

D. Outdoor drain pan with drain connection: provide where outdoor units are subject to defrost and located in an area where melting ice could pose a nuisance/safety issue. Extend drain piping to a safe area.

E. Condensate pump: provide where condensate drain piping cannot be installed to achieve gravity flow.

PART 3 - EXECUTION

3.1 GENERAL

A. Units shall be installed as indicated and in strict accordance with manufacturer’s recommendations and installation instructions.

B. Units shall be installed level.

C. Test for positive condensate drainage.

D. Units shall be installed to allow adequate service to all components.

E. Review the Installation, Operation, and Maintenance Manual with the Owner’s representative.

END OF SECTION

SECTION 23 81 28.13

DUCTLESS SPLIT SYSTEM HEAT PUMPS (1 to 3½ TONS)

PART 1 - GENERAL

1.1 DESCRIPTION

A. All work specified herein shall be accomplished in accordance with the applicable requirements of Section 23 00 00 - HVAC General.

B. Furnish and install direct expansion air-to-air split system heat pump units of the size and capacity shown on the equipment schedule. The unit shall be completely factory assembled and tested, and shall include variable speed compressor, indoor and outdoor coils, fan motors, wireless or wired remote controller, interconnecting refrigerant tubing, and power and control wiring. The outdoor unit shall be of the inverter driven design and factory matched with the indoor unit.

C. Equipment schedules and specifications are intended to establish a minimum level of quality and workmanship for the project. When other than the basis of design equipment is proposed, the Contractor shall be responsible for all costs associated with engineering and construction modifications necessary in his or any other trade that may be required to satisfy the Contract Documents.

D. Refer to the drawings for basis of design manufacturer and acceptable alternates.

1.2 RELATED DOCUMENTS

A. For piping, valves, accessories and piping insulation refer to Section 23 23 00 – Refrigerant Piping.

1.3 QUALITY ASSURANCE

A. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL) and shall bear the ETL label.

B. All wiring shall be in accordance with the National Electrical Code (NEC).

C. The units shall be rated in accordance with Air-conditioning, Heating, and Refrigeration Institute’s (AHRI) Standard 210/240 and bear the AHRI Certification label.

D. The units shall be manufactured in a facility registered to ISO 9001 and ISO 14001.

E. A dry air holding charge shall be provided in the indoor section.

F. System efficiency shall meet or exceed the scheduled values.

G. Delivery, Storage and Handling:

1. Equipment shall be stored and handled according to the manufacturer’s recommendations.
2. The controller shall be able to withstand storage temperature of 105°F and 95% relative humidity without any adverse effects.

1.4 SUBMITTALS

A. Product Data: Include performance data (including extended capacity ratings if other than AHRI standard conditions are scheduled); installation, operation and maintenance manual; operating characteristics; furnished specialties; and accessories.

B. Submit AHRI Certificates.

1.5 COORDINATION

A. Coordinate size, weight and location with Architectural and Structural drawings. Where concrete pads are indicated, conform to Division 03 for concrete, reinforcement, and formwork requirements.

1.6 WARRANTY

A. The indoor and outdoor units shall carry a manufacturer's standard parts and defects warranty for a period five (5) years from the date of installation. The compressor shall carry a warranty of seven (7) years from the same date of installation. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer.

PART 2 - PRODUCTS

2.1 INDOOR UNITS

A. The indoor units shall be following types: wall mount, ceiling recessed cassette. All indoor units shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, control circuit board, fan and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function after power interruption. Indoor unit shall be purged with dry air before shipment from factory.

B. Wall Mount Type:

1. Unit Cabinet:
   a. The cabinet shall be formed from high strength molded plastic with smooth finish, flat front panel design with access for filter. Cabinet color shall be white.
   b. A separate metal installation plate that secures the indoor unit firmly to the wall shall be furnished with the unit. The installation plate shall be securely attached to the wall using an appropriate anchoring method for the wall type the unit will be attached to.
2. Fan:
   a. The fan shall be a high performance direct drive double inlet forward curved sirocco type design driven by a single motor. The fan shall be statically and dynamically balanced and be powered by a motor with permanently lubricated bearings.
   b. The fan shall have three (3) speeds: Low, Mid, High and Auto. The fan shall have a selectable Auto fan setting that will adjust the fan speed based on the difference between controller set-point and space temperature.
3. Directional Air Flow Vane: An integral, motorized multi-position vane shall automatically direct air flow in a horizontal and downward direction to provide uniform air distribution.
4. Filter: Return air shall be filtered by means of an easily removable washable filter.
5. Coil:
   a. The indoor unit coil shall be of nonferrous construction with pre-coated aluminum strake fins on copper tubing. The multi-angled heat exchanger shall have a modified fin shape that reduces air resistance for a smoother, quieter airflow.
   b. All tube joints shall be brazed with PhosCopper or silver alloy.
   c. The coils shall be pressure tested at the factory.
   d. A condensate pan and drain shall be provided under the coil.
   e. Condensate overflow protection: a drain pan water level switch, designed to connect to the control board and shut the unit off, shall be provided when scheduled.
   f. A condensate mini-pump shall be provided when scheduled to provide a means of

condensate disposal when a gravity drain is not available.

C. Ceiling Recessed Cassette Type:

1. Unit Cabinet:
   a. The cabinet shall be formed from galvanized sheet metal coated with high-density foam insulation. The cabinet shall be designed for recessed mounting and provided with four (4) corner mounting supports behind removable corner pockets located in the grille assembly allowing adjustment of mounting height from the front of the unit.
   b. The cabinet panel shall have provisions for a field installed filtered outside air intake.
   c. The cabinet shall have a knock-out for the connection of a branch supply air duct to condition a secondary space.
   d. The cabinet shall have an optional multi-function casement which will mount between the unit cabinet and the Grille assembly to provide a second field installed filtered outside air intake and provide a mount for a high-efficiency filter element.
   e. A separate grille assembly shall be attached to the front of the cabinet with supply air vanes to supply air in four directions. The four-way grill shall allow two, three or four-way blow. The grille vane angles shall be individually adjustable from the wired remote controller. The return air intake shall be located in the center section of the grille. The grille assembly shall be white.
2. Fan:
   a. The fan shall be a direct drive turbo propeller design driven by a single motor. The fan shall be statically and dynamically balanced and be powered by a motor with permanently lubricated bearings.
   b. The fan shall have four (4) speeds: Low, Mid1, Mid2, High and Auto. The fan shall have a selectable Auto fan setting that will adjust the fan speed based on the difference between controller set-point and space temperature.
3. Directional Air Flow Vane: An integral, motorized multi-position vane shall automatically direct air flow in a horizontal and downward direction to provide uniform air distribution.
4. Filter:
   a. Return air shall be filtered by means of an easily removable washable filter.
5. Coil:
   a. The indoor unit coil shall be of nonferrous construction with pre-coated aluminum strake fins on copper tubing. The heat exchanger shall have a modified fin shape that reduces air resistance for a smoother, quieter airflow.
   b. All tube joints shall be brazed with PhosCopper or silver alloy.
   c. The coils shall be pressure tested at the factory.
   d. A condensate pan and drain shall be provided under the coil.
   e. Condensate overflow protection: a drain pan water level switch, designed to connect to the control board and shut the unit off, shall be provided when scheduled.
   f. A condensate mini-pump shall be provided when scheduled to provide a means of condensate disposal when a gravity drain is not available.

2.2 OUTDOOR UNIT

A. General:

1. The outdoor unit shall be specifically designed and matched to operate with the indoor unit. The outdoor unit shall be completely factory assembled, piped and wired and run tested at the factory.
2. The outdoor unit shall be equipped with an electronic control board that interfaces with the indoor unit to perform all necessary operation functions.
3. The unit shall be capable of cooling operation down to 23°F (-5°C) ambient temperature without additional low ambient controls (an optional wind baffle shall be required for cooling

operation down to 0°F (-17.7°C). Heating shall be available between 17°F (-8°C) and 70°F (21°C) ambient without any additional controls or accessories.

4. The outdoor unit shall be able to operate with a maximum height difference of 100 feet (30 meters) between the indoor and outdoor units.
5. System shall be capable of operation up to a maximum refrigerant tubing length of 100 feet (30 meters) for the 1 and 1½ ton units and 165 feet (50 meters) for the 2 thru 3½ ton units between indoor and outdoor units without the need for line size changes, traps or additional oil.

B. Unit Cabinet:

1. The casing shall be fabricated of galvanized steel finished with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection.
2. Serviceable parts shall be accessible by means of removable panel sections.
2. Cabinet color shall be the manufacturer's standard color.
3. The unit shall have two (2) mild steel mounting feet, transversely mounted and welded to the cabinet base pan. The mounting feet shall have a slotted mounting hole at each end for a total of four (4) mounting holes. The cabinet assembly shall be sufficient to withstand 155 MPH wind speed conditions for use in Hurricane condition areas.

C. Fan:

1. The unit shall be furnished with single or dual direct drive fan wheels.
2. The fan motor shall be a direct current (DC) motor with permanently lubricated bearings.
3. The fan motor shall be mounted for quiet operation.
4. The unit shall be provided with a raised fan safety guard to prevent contact with moving parts.
5. The outdoor unit shall have horizontal discharge airflow.

D. Coil:

1. The L shaped condenser coil shall be constructed of copper tubing with flat aluminum fins to reduce debris build up and allow maximum airflow. The coil shall be protected with an integral metal guard.
2. Refrigerant flow from the outdoor unit shall be regulated by means of an electronic linear expansion valve (LEV) metering device.
3. The outdoor unit shall be pre-charged with sufficient refrigerant to accommodate up to twenty-five (25) feet of refrigerant piping for capacities up to 18,000 btu/hr., and up to thirty-three (33) feet of refrigerant piping for capacities above 18,000 btu/hr.
4. Refrigerant linesets between the outdoor and indoor units shall be annealed refrigeration grade copper tubing, Type ACR, meeting ASTM B280 requirements. The lines shall be individually insulated in twin-tube, flexible, closed-cell, CFC-free (ozone depletion potential of zero), elastomeric material for the insulation of refrigerant pipes and tubes with a thermal conductivity equal to or better than 0.27 BTU-inch/hour per ft^2/°F and a water vapor transmission equal to or better than 0.08 Perm-inch. Insulation thickness shall be as required to satisfy project specific energy code requirements (refer to Section 23 23 00 Refrigerant Piping for additional information). Insulation shall have a Flame-Spread Index of less than 25 and a Smoke-development Index of less than 50 as tested by ASTM E 84 and CAN/ULC S-102.
5. Refrigerant piping connections between the outdoor and indoor units shall be flare type.

E. Compressor:

1. The compressor shall be the high performance, hermetic, inverter driven, variable speed, dual rotary type.
2. The compressor motor shall be the direct current (DC) type equipped with a factory installed inverter drive package.

3. The outdoor unit shall be equipped with an accumulator and high pressure safety switch.
4. The compressor shall be equipped with internal thermal overload protection.
5. To prevent liquid from accumulating in the compressor during the off cycle, a minimal amount of current shall be automatically, intermittently applied to the compressor motor windings to maintain sufficient heat to vaporize any refrigerant. No crankcase heater will be required.
6. There shall be no need for line size changes. Filters, sight glasses, and traps shall not be used, and no additional refrigerant oil shall be required.
7. The compressor shall be resiliently mounted to reduce vibration transmission.

F. Electrical:

1. The unit electrical characteristics shall be 208/230 volts, 1-phase, 60 hertz and shall be capable of satisfactory operation within voltage limits of 187 volts to 253 volts.
2. The outdoor unit shall be controlled by the microprocessor located in the indoor unit. The control signal between the indoor unit and the outdoor unit shall be pulse signal 24 volts DC. The unit shall have a Pulse Amplitude Modulation circuit to utilize 98% of the input power supply.

2.3 CONTROLS

A. General:

1. The system shall have either a wired remote controller as scheduled to perform input functions necessary to operate the system.
2. The controllers shall have a Power On/Off switch, Mode Selector – Auto, Cool, Heat, Dry Modes - Temperature Setting, Timer Control with Clock, Fan Speed Select and Vane / Airflow Direction selector. Controllers shall have a programmable Smart Set button for pre-selected Temperature, Fan Speed, and Vane position settings.
3. The controller shall support multiple languages (Spanish, German, Japanese, Chinese, English, Russian, Italian, or French) for display information.
4. The indoor unit shall be capable of performing self-diagnostic functions and check mode switching.
5. Temperature changes shall be displayed in 1ºF (1ºC) increments with a range of 61 - 88ºF (16-31ºC).
6. The microprocessor located in the indoor unit shall have the capability of sensing return air temperature and indoor coil temperature, receiving and processing commands from the wireless or a wired controller, providing emergency operation and controlling the outdoor unit.
7. The system shall be capable of automatically restarting and operating at the previously selected conditions when the power is restored after power interruption.
8. Control system shall control the continued operation of the air sweep louvers, as well as provide On/Off, System/Mode function.
9. Controller:
   a. Wired wall mounted remote controller: The wired remote controller shall be furnished with a communications interface to communicate with the indoor unit. The interface will be mounted at the indoor unit.
      The wired remote controller shall have a light-green LCD display. There shall be a built-in weekly timer with up to 8 pattern settings per day. The controller shall consist of an On/Off button, Increase/Decrease Set Temperature buttons, a Cool/Auto/Fan/Dry mode selector, a Timer Menu button, a Timer On/Off button, Set Time buttons, a Fan Speed selector, a Ventilation button, a Test Run button, and a Check Mode button. The controller shall have a built-in temperature sensor.

2.4 ACCESSORIES

A. Wind Guard/Baffle: if specified or if required to achieve proper operation due to high wind conditions and/or low ambient operation.

B. Wall mounting bracket (if specified): factory fabricated painted steel bracket to accept outdoor unit mounting holes, secure to wall and provide manufacturer recommended airflow and maintenance clearances.

C. Air outlet guide: provide where multiple units are arranged for series airflow at less than manufacturer's recommended airflow clearance.

D. Outdoor drain pan with drain connection: provide where outdoor units are subject to defrost and located in an area where melting ice could pose a nuisance/safety issue. Extend drain piping to a safe area.

E. Condensate pump: provide where condensate drain piping cannot be installed to achieve gravity flow.

PART 3 - EXECUTION

3.1 GENERAL

A. Units shall be installed as indicated and in strict accordance with manufacturer's recommendations and installation instructions.

B. Units shall be installed level.

C. Test for positive condensate drainage.

D. Units shall be installed to allow adequate service to all components.

E. Review the Installation, Operation, and Maintenance Manual with the Owner's representative.

END OF SECTION

SECTION 23 82 39

ELECTRIC UNIT HEATERS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. All work specified herein shall be accomplished in accordance with the applicable requirements of Section 23 00 00 - HVAC General.

1.2 WORK INCLUDED

A. Receipt, unloading, handling, proper storage, and protection from damage of all materials.

B. Layout and coordination of work with other trades.

C. The work under this section shall include all labor, materials, accessories, services, and equipment necessary to furnish and install electric unit heaters complete as indicated on the Drawings and as specified herein.

D. Refer to the drawings for approved manufacturers.

1.3 QUALITY ASSURANCE

A. Electric heaters shall be constructed in accordance with provisions of the National Electrical Code and shall be UL or ETL tested and listed to UL Standard 2021 – UL Standard for Safety Fixed and Location-Dedicated Electric Room Heaters.

PART 2 - PRODUCTS

2.1 UNIT HEATERS

A. Unit shall be of the horizontal or vertical discharge fan-forced propeller type.

B. Casing shall be constructed of heavy gauge die-formed, furniture grade steel, phosphate coated and finished in baked enamel.

C. The heating element shall be aluminum-finned with a copper clad steel sheath.

D. Fan shall be direct drive propeller type designed specifically for unit heater applications.

E. The motor shall be totally enclosed, thermally protected, continuous duty type selected to match airflow requirements.

F. Unit shall be provided with the manufacturer’s standard mounting bracket for either ceiling or wall mounting as required.

G. Unit shall be equipped with individually adjustable horizontal discharge louvers.

H. Wiring shall be designed for a single source power connection with elements, motor and control circuits subdivided and fused to conform to the latest National Electrical Code, OSHA, and Underwriters Laboratories Inc. standards. All three phase heaters shall have balanced phases. A factory wired non-fused disconnect switch shall be provided. Control circuit voltage shall not exceed 120 volts.

I. Unit heater shall be equipped with an automatic reset linear thermal cut-out, a fan delay switch, and control circuit transformer.

J. Thermostat shall be unit mounted or wall mounted as shown on the Drawings.

2.2 CEILING HEATERS

A. Unit shall be of the vertical discharge fan-forced type.

B. Housing shall be constructed of heavy gauge steel with a baked-on powder coat finish.

C. The grille shall be constructed of 18-gauge powder coated steel.

D. The heating element shall be the block-finned type with parallel steel fins.

E. Fan shall be the direct drive propeller or vane axial type.

F. The motor shall be totally enclosed, thermally protected, continuous duty type selected to match airflow requirements.

G. Unit shall be provided with the manufacturer's standard mounting hardware for ceiling mounting.

H. Wiring shall be designed for a single source power connection with elements, motor and control circuits subdivided and fused to conform to the latest National Electrical Code, OSHA, and Underwriters Laboratories standards. A factory wired non-fused disconnect switch shall be provided. Control circuit voltage shall not exceed 120 volts.

I. Ceiling heater shall be equipped with a manual reset thermal limit (integral thermostat) or automatic reset thermal limit (remote wall mounted thermostat), a fan delay switch, and control circuit transformer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All units shall be installed in strict accordance with the manufacturer's installation instructions.

B. In areas where heaters are used for freeze protection, thermostat setpoint shall be adjusted to 40°F.

END OF SECTION

SECTION 23 82 39.19

ELECTRIC WALL HEATERS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. All work specified herein shall be accomplished in accordance with the applicable requirements of Section 23 00 00 - HVAC General.

1.2 WORK INCLUDED

A. Receipt, unloading, handling, proper storage and protection from damage of all materials.

B. Layout and coordination of work with other trades.

C. The work under this section shall include all labor, materials, accessories, services, and equipment necessary to furnish and install wall heaters complete as indicated on the Drawings and as specified herein.

PART 2 - PRODUCTS

2.1 WALL HEATERS

A. Unit shall be completely factory assembled, wired, tested and shipped as a single assembly; capacity shall be as indicated on the Drawings.

B. Unit heaters shall be constructed in accordance with provisions of the National Electrical Code and shall be UL or ETL tested and listed to UL Standard 2021 – UL Standard for Safety Fixed and Location-Dedicated Electric Room Heaters.

C. Front grille shall be 16-gauge steel or aluminum finished in baked enamel or anodized with downflow discharge louvers.

D. Element shall consist of helically coiled nickel chromium alloy resistance wire enclosed in corrosion resistant sheaths.

E. Controls shall include fan delay switch, built-in thermostat, automatic reset thermal overload switch and a non-fused disconnect power switch.

F. Unit shall be designed to either recess into the wall or for surface mounting as scheduled and shall include all mounting accessories.

G. Unit shall be Raywall, QMark, Markel, Berko, Indeeco or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All units shall be installed in strict accordance with the manufacturer’s recommendations.

END OF SECTION

SECTION 26 00 00

ELECTRICAL GENERAL

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. General Conditions: Refer to the General Conditions, the Supplementary General Conditions and the Special Conditions, all provisions of which apply to work under this section as if written in full herein.

B. The scope of work to be done under this section of the specifications shall include the furnishing of labor, material, equipment and tools required for the complete installation of systems for power, lighting, signals and all other work indicated on the drawings or as specified herein. A 100% operational building and electrical distribution system up to a connection point for Owner furnished equipment will be provided.

C. The drawings and specifications are complementary to each other and what is called for by one shall be as binding as if called for by both.

1.2 STANDARDS

A. All work shall conform to all ordinances and regulations of the City, County, State and/or other authorities having jurisdiction in accordance with the requirements of the following codes, standards and design guides:

1. The 2023 edition of the National Electrical Code (NFPA 70) with local Amendments
2. The 2021 edition of the International Building Code with local Amendments
3. The 2019 edition of the Life Safety Code (NFPA 101)
4. 2021 IECC
5. Regulations of the local utility company with respect to metering and service entrance
6. Local city and county ordinances governing electrical work
7. Americans with Disabilities Act (Public Law 101-336)

1.3 PERMITS

A. The Contractor shall obtain all permits and inspections required for the installation of this work and pay all charges incident thereto. He shall deliver to the Architect all certificates of said inspection.

1.4 WORK INCLUDED

The electrical systems installed and work performed under this division of the specifications shall include, but not necessarily be limited to, those listed below. All materials and appliances, obviously a part of the electrical systems and necessary to its proper operation, but not specifically mentioned or shown on the drawings, shall be furnished and installed without additional charge.

A. Power Distribution System

B. All lighting systems (indoor and outdoor, normal, emergency and exit) including all fixtures, lamps, plaster and/or tile frames, standards, switches, outlets, wiring, dimmers, contactors, time clocks, photocells, batteries, raceways and other components and fittings required for complete lighting systems

C. Wiring, including power circuit connections for HVAC, plumbing and other mechanical equipment

D. Grounding Systems

E. Temporary service lighting and power system

F. Low voltage system raceways and equipment mounting boards as indicated on the drawings

G. Underground raceway excavation, backfill, and compaction

H. Fire Alarm System

I. Concrete work for duct banks, manholes, covering, lighting standard bases and equipment bases (where not assigned to General Contractor)

J. Electrical Equipment Identification

K. Supporting Devices for Electrical Components

L. Work as required by electric and telecommunication utilities, as well as the coordination of additional work (i.e. work performed by the utility) with that of other trades

1.5 DRAWINGS

A. Drawings are generally diagrammatic and show the arrangement and location of fixtures, equipment and conduit. The Contractor shall carefully investigate the structural and finish conditions affecting his work and arrange his work accordingly. Should conditions on the job make it necessary to rearrange conduit or equipment, the Contractor shall so advise the Engineer and secure approval before proceeding with such work.

B. Where exact locations are required by equipment for stubbing-up and terminating conduit concealed in floor slabs, the Contractor shall request shop drawings, equipment location drawings, foundation drawings, and any other data required by him to locate the concealed conduit before the floor slab is poured.

C. Materials, equipment or labor not indicated but which can be reasonably inferred to be necessary for a complete installation shall be provided. Drawings and specifications do not undertake to indicate every item of material, equipment, or labor required to produce a complete and properly operating installation.

D. Locate pull boxes, panelboards, control pushbuttons, terminal cabinets, safety switches and such other apparatus as may require periodic maintenance, operation, or inspection, so that they are easily accessible. If such items are shown on the plans in locations which are found to be inaccessible, the Engineer must be advised of the situation before work is advanced to the point where extra costs will be involved.

E. All additional circuit connections to panelboards must be preapproved by the Engineer.

F. The location, arrangement and extent of equipment, devices, conduit, and other appurtenances related to the installation of electrical work shown on drawings are approximate. The Contractor shall not scale drawings, but shall refer to the architectural drawings for exact dimensions of building components. Should a conflict exist between the architectural and engineering drawings regarding dimensions and scale, the Contractor shall notify the Architect of the discrepancy.

G. Verify the ceiling type, ceiling suspension systems, and clearance above hung ceilings prior to ordering lighting fixtures. Notify the Engineer of any discrepancies.

H. Review all architectural drawings for door swings, cabinets, counters and built-in equipment.

1.6 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall prepare a minimum of two (2) instruction manuals, one of which shall be submitted to the Architect for the Engineer's review, describing installation, operation and maintenance of all Electrical equipment. Manuals shall include copies of control schematics, sequences of operation, indicate the function and operations of all components, as well as the Contractor's name, address, and telephone number. Manuals shall also contain one copy of all manufacturer's drawings, pamphlets, data, parts lists, and instruction manual for each piece of equipment. Upon approval, one copy shall be delivered to the Owner; one copy shall be kept by the Contractor. The pamphlets and drawings are to be neatly bound in a 3-ring binder(s).

1.7 AS-BUILT DRAWINGS

A. The Contractor shall maintain a record of all changes in the work from that shown in the Contract Documents. After all work is completed, the Contractor shall prepare a set of "as-built" reproducible drawings of similar type and quality as the Contract Drawings that reflect all changes and that accurately show actual final construction, and deliver these drawings to the Architect.

1.8 EQUIPMENT, MATERIALS AND BID BASIS

A. Manufacturers' names, model numbers, etc. as specified on the drawings and herein are for the purpose of describing type, capacity, function and quality of equipment and materials required.

B. Unless "approved equal" is specifically stated, bids shall be based on equipment names in specifications or on drawings as "base" products.

C. "Equal product" and "approved equal" items listed shall conform to specified base items and shall be substantially equal in size, weight, construction and capacities. The "equal" equipment and materials shall be submitted as full equivalent to the equipment and materials specified, with sufficient supportive documentation and technical literature to demonstrate quality, performance, and workmanship without doubt or question. Submittals for "equal" products shall be made at least ten (10) days prior to bid (refer to the General Conditions of these specifications). The Engineer shall consider the use of the "equal" equipment based on the supportive documentation available to him, and shall approve or disapprove any proposed alternates. The decision of the Engineer shall, in all cases, be final.

D. The Contractor shall coordinate the installation of all electrical equipment proposed for use in this project with all building trades (architectural, structural, mechanical, etc.). Coordination shall be accomplished prior to, and shall be reflected in, the submittal of shop drawings for approval. When substitution of equipment is made, the Contractor shall be responsible for the costs of any item and engineering and construction revisions necessary in his or any other contract or trade that may be required to satisfy the plans and specifications.

E. If substitutions are made in lieu of equipment specified, the manufacturer's literature shall be submitted to the Engineer for approval. In the case of lighting fixtures, full IES photometric test reports for the fixture, lamp(s), and lenses shall be submitted for approval.

1.9 SUBMITTALS

A. The Contractor shall prepare, submit, and obtain Engineer's review of manufacturers' submittals on the following equipment and systems prior to ordering, purchasing, or installation of any equipment or materials. All required submittals shall be transmitted electronically (e.g. pdfs, etc.) with the

associated specification section and the item submitted clearly identified. Partial submittals will be returned without review.

1. Submit a listing of all the materials indicated below, with the type of material, manufacturer and catalog or model number for each (where applicable):
   Package #1
   Conductors
   Conduit
   Multiconductor Cables
   Wiring Devices and Plates
   Disconnect Switches
2. Submit complete shop drawings of the following when supplied by the electrical contractor:
   Package #2
   Fuses and/or Circuit Breakers
   Switchboards
   Transformers
   Modular Meter Centers
   Surge Protective Devices
   Motor Control Centers with typical schematic of starters
   Panelboards and Cabinets
   Cable Tray and Tray Fittings
   Busway
   Package #3
   Lighting Fixtures
   Occupancy Sensors
   Lighting Control Panels
   Time Switches
   Photocells
   Lighting Contactors
   Package #4
   Generator Set
   Transfer Switch
   Package #5
   Fire Alarm System
3. Submit test reports as required in section 3.07 - Electrical Testing.

B. All shop drawing approvals required by any code or enforcement authority, insurance underwriter, etc. shall be obtained prior to being submitted to the Engineer.

C. Review of shop drawings by the Engineer does not relieve the Contractor from responsibility for complying with all requirements of the Contract Documents. Furthermore, it shall be the responsibility of the Contractor to coordinate the requirements (roof penetrations, wall penetrations, floor penetrations, curbs, electrical, etc.) of all approved equipment with the other trades and disciplines at no additional cost.

D. All shop drawings shall be identified by the equipment mark or tag identification numbers shown on the Contract Drawings. Each individual submittal item shall be marked to show which specification section pertains to the item.

1.10 COORDINATION OF TRADES

A. The Contractor shall give full cooperation to other trades, and shall furnish all information necessary to permit the work of all trades to be installed satisfactorily and with least possible interference or delay.

B. Work shall not be performed without first coordinating the installation of same with other trades. The Contractor, at his own expense, shall relocate all uncoordinated equipment installed should they interfere with the proper installation and mounting of mechanical equipment, ceilings and other architectural or structural finishes.

C. The Contractor shall coordinate the elevations of all equipment above ceilings and in exposed areas with the work of all other disciplines prior to installation.

D. In areas where more than one trade is required to use common openings in beams, joists, chases, shafts and sleeves for the passage of conduits, raceways, piping, ductwork and other materials, the Contractor must coordinate the positions of all piping and equipment to be furnished under this section so that all items including the materials and equipment of other trades may be accommodated within the space available.

E. The Contractor shall confirm that work installed under this section does not interfere with the clearances required for finished columns, pilasters, partitions, walls or other architectural or structural elements as shown on the Contract Documents.

F. Work that is installed under this Contract which interferes with the architectural design or building structure shall be removed and relocated as required at no additional cost to the Contract.

1.11 WARRANTY

A. All equipment furnished and installed under this Contract shall be provided with the manufacturer's standard warranty unless otherwise noted.

B. The Contractor shall make good all defects in material, equipment, or workmanship disclosed within a period of one (1) year from date of building acceptance by the Owner. The phrase "make good" shall mean to furnish promptly, without charge, all work necessary to remedy the defects to the satisfaction of the Engineer.

1.12 TEMPORARY LIGHT AND POWER

A. The Contractor shall provide a temporary service of the amperage and voltage required by the Project Manager.

B. Sufficient wiring, outlets and lamps shall be installed to ensure proper lighting in accordance with OSHA, state and municipal codes. Refer to Division 1 specifications for requirements.

1.13 EQUIPMENT REQUIRING ELECTRICAL SERVICE

A. Review all specification sections and drawings including mechanical, plumbing and other equipment drawings and other divisions of the specifications for equipment requiring electrical service. Provide service to and make connections to all such equipment requiring electrical service.

B. Prior to installing material such as electrical equipment, devices, feeders, or branch circuits serving equipment of all other trades, the Contractor shall coordinate with the electrical requirements of the equipment to be installed.

1.14 MECHANICAL SYSTEMS COORDINATION

A. All control wiring for mechanical systems shall be installed under Division 23.

B. Motor controllers (starters) shall be furnished under Division 23 and installed under Division 26, unless specified otherwise.

C. Power wiring to all motors and motor controllers and between motors and controllers shall be provided in Division 26.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. All equipment, materials, accessories, etc. used shall be new and of current production unless specified otherwise. Equipment not specified in the Contract Documents shall be suitable for the intended use and shall be subject to approval by the Engineer.

B. All equipment, products and materials shall be free of defects and shall be constructed to operate in a safe manner without excessive noise, vibration, leakage, or wear.

C. All equipment shall bear the inspection label of Underwriters Laboratories Inc.

D. All equipment and material for similar applications or systems shall be provided from the same manufacturer unless noted otherwise.

E. The published standards and requirements of the National Electrical Manufacturers Association, the American National Standard Institute, the Institute of Electrical and Electronic Engineers, and the American Society of Testing Materials, are made a part of these specifications and shall apply wherever applicable.

2.2 IDENTIFICATION

A. Equipment or devices specified in the individual sections to be identified shall be identified by machine cut stencil unless the equipment is identified by the manufacturer. Identification of flush mounted cabinets and panelboards shall be on the inside of the device. Surface mounted equipment shall be identified on the outside cover. Equipment operating on 208Y/120 volt system shall be identified with black labels with white inner core, 480Y/277 volt equipment with red labels with white inner core.

B. All switchboards and panelboards supplied by a feeder shall be stencil-labeled to indicate the equipment where the power supply originates.

C. Each disconnecting means shall be stencil-labeled to indicate its purpose unless located and arranged so the purpose is evident. The label shall include the identification of the circuit source that supplies the disconnecting means.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Mounting heights, unless otherwise noted, are to be center line of the equipment and/or device except the mounting height of suspended light fixtures which is to the bottom of fixture.

B. All work shall be designed and installed to comply with the requirements for the seismic design category and use group for the area in which the building is constructed.

3.2 EXCAVATION, TRENCHING & BACKFILLING

A. Contractor shall call underground utilities locator company before digging.

B. Barricades shall be provided around open holes and trenches. Temporary bridges shall be provided over trenches cut through major sidewalk routes. Major sidewalk routes shall not be closed to pedestrian traffic.

C. Barriers shall be provided to protect landscaping adjacent to the excavation area.

D. When rocks, concrete or other debris are encountered during excavation, remove completely.

E. Where sidewalk sections must be removed for installation of underground ducts, remove the sidewalk sections completely from joint to joint.

F. Where asphalt must be removed for installation of underground ducts, saw cut the asphalt in two, straight, parallel lines.

G. Backfill excavations in 6-inch layers and mechanically compact to 98 percent compaction.

H. Excavated materials may be used as backfill only if the backfill is sand or clean dirt that is free of rocks and debris over 3/4" in diameter.

I. In landscaped areas, backfill and mechanically compact to a depth of 6 inches below grade.

J. Backfill the last 6 inches with clean topsoil. Reseed lawn areas.

K. Restore concrete sidewalks and asphalt.

L. The Contractor shall perform all excavation to install the work herein specified and as indicated on drawings. During excavation, material for backfilling shall be piled back from the banks of the trench to avoid overloading and to prevent slides and cave-ins. All excavated materials not to be used for backfill shall be removed and disposed of by the Contractor. Grading shall be done to prevent surface water from flowing into trenches and other excavation and any water accumulating therein shall be removed by pumping. All excavation shall be made by open cut. No tunneling shall be done except under pavement.

M. The bottom of the trenches shall be graded to provide uniform bearing and support for conduits, cables, or duct bank on undisturbed soil at every point along its entire length. Overdepths shall be backfilled with loose, granular, moist earth, and tamped. Remove unstable soil that is not capable of supporting equipment or installation and replace with specified material for a minimum of 12" below invert of equipment or installation.

N. The trenches shall be backfilled with the excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand and gravel or soft shale, free from large clods of earth and stones, deposited in 6" layers and tamped until the crown of the pipe is covered by a minimum of 6" of tamped earth. The backfill under and beside the pipe shall be compacted for pipe support. Backfill shall be brought up evenly on both sides of the pipe so that the pipe remains aligned. In instances where the manufacturer’s installation instructions for materials are more restrictive than those prescribed by the code, the material shall be installed in accordance with the more restrictive requirement. The backfilling shall be carried on simultaneously on both sides of the trench so that injurious pressures do not occur. The compaction of the filled trench shall be at least equal to 98% of the maximum density as determined by the Standard Proctor Test. Settling the backfill with water will not be permitted. Reopen any trenches not meeting compaction requirements or where settlement occurs,

refill, compact, and restore the surface to the grade and compaction indicated, mounded over and smoothed off. A metallic lined underground warning tape shall be provided 12" below finished grade. The tape shall be red for electrical lines and orange for telephone and shall be identified as to the type of line.

O. Perform excavation and backfilling work in accordance with applicable portions of the earthwork section.

3.3 STORAGE AND PROTECTION OF MATERIALS

A. Refer to the general requirements section of the specifications, Division 1, for storage, protection, and handling requirements.

B. Inspect materials upon arrival at project and verify conformance to Contract Documents. Prevent unloading of unsatisfactory material.

C. Store packaged materials in original undamaged condition with manufacturer’s labels and seals intact.

D. Containers which are broken, opened, watermarked, or otherwise damaged materials are unacceptable and shall be removed from premises.

E. Equipment and materials shall not be installed until such time as the environmental conditions of the job site are suitable to protect the equipment or materials. Equipment or materials damaged or which are subjected to these elements are unacceptable and shall be removed from the premises and replaced.

3.4 CONCRETE WORK

A. Construct curbs, pads, vaults and similar supports for electrical equipment where required.

B. Provide 4" thickness housekeeping pads at floor mounted equipment, covering entire area occupied by equipment. Dowel pads to structural slab.

C. Perform concrete work in accordance with applicable portions of Concrete sections. Minimum compressive strength of concrete shall be same as specified for slabs on grade.

3.5 PAINTING

A. Except as otherwise specified, painting shall be accomplished under Painting Section. Surfaces shall be left clean of debris and free from oil and other substances which would prevent paint bond.

B. Touch up finishes of factory painted apparatus where finish is marred during installation.

C. Where galvanizing is broken during fabrication or installation, recoat exposed areas with cold galvanizing compound.

D. Do not paint over nameplates on equipment, nonferrous hardware, accessories or trim.

3.6 WORKMANSHIP

A. Install systems, materials and equipment level and plumb, parallel and perpendicular to other building systems and components.

3.7 ELECTRICAL TESTING

A. Furnish all labor, materials, instruments, supplies, and services and bear all costs for the accomplishment of the tests herein specified or requested at job site. Correct all defects appearing under test, and repeat the tests until no defects are disclosed, leave the equipment clean and ready for use.

B. All grounds, crosses, shorts, etc., must be eliminated from the wiring. Test all lighting fixtures, together with switches and controls; test the operation of all motors, controllers, and other electrical equipment devices.

C. The switchboard and all feeders shall be Meggar tested. A copy of all test reports shall be given to the Engineer.

D. The Contractor shall perform any tests other than herein specified which may be required by the Engineer or the authority having jurisdiction.

E. Perform the following tests after installation but before energizing the equipment. The following tests and procedures apply to all equipment and material that is to be tested under this Contract.

1. Transformers
    a. Visually inspect all components for damage, check bushings and insulators for cracks; transformer casing for evidence of leakage; pressure, temperature and liquid level gauges for proper indications.
2. Ground Resistance
    a. Visually inspect for specified ground connections.
    b. Perform ground resistance test at all connections to switchboards and panelboards.
    c. Use three point or fall of potential method.
    d. Verify single point connection (at the counterpoise) between the grounded and grounding systems.
    e. Additional ground rod is required if resistance is greater than 25 ohms.
3. Switchboards and Panelboards
    a. Visually inspect all components for damage.
    b. Check operation of circuit breakers/fusible switches.
4. Ground Fault Systems
    a. Visually inspect for damage and improper connections.
5. Transfer and Other Relay Schemes
    a. Investigate intended function and verify correct operation.

F. The Engineer shall be notified immediately of any unfavorable test results or indication of faulty equipment. No piece of equipment shall be energized until the test data is evaluated and the equipment is proven acceptable.

G. If the test and inspection data submitted should indicate deficiencies in the operation of the electrical apparatus or in the manufacturer thereof, the Contractor shall promptly implement the necessary adjustments, corrections, modifications and/or replacements necessary to meet the specified requirements.

3.8 COMMISSIONING

A. The following systems shall be commissioned in accordance with the requirements of the 2021XX IECC:

1. Occupant Sensor controls

2. Time Switch controls
3. Daylight responsive controls

B. Programming of sensors, controls, switches, schedules, VFD operation and other systems shall be set by the installing contractor.

C. The following shall be provided to the building owner or owner representative within 90 days after the date of system acceptance.

1. Submittals, Shop drawings
2. Installation instructions, operations and maintenance instructions for each piece of equipment and system installed.
3. Maintenance schedule
4. Names and address of at least one service agency.
5. Lighting controls system maintenance and calibration information, including wiring diagrams, schematics, and control sequence descriptions. Desired or field determined set-points shall be permanently recorded on control drawings at control devices or for digital control systems, in programming comments.
6. A complete narrative of how each system is intended to operate, including suggested setpoints.

3.9 TRAINING

A. Upon completion of the work, the Contractor shall conduct operation and training session(s) for the Owner's key personnel. These sessions shall be of sufficient length and duration to adequately explain the design intent and proper operating and maintenance techniques for all equipment and systems. After these sessions are completed, the Contractor shall provide a copy of a signed statement by the Owner that his personnel are thoroughly familiar with and capable of operating all equipment and systems.

END OF SECTION

SECTION 26 05 19

CONDUCTORS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. All work specified herein shall be accomplished in accordance with the applicable requirements of Section 26 00 00 - Electrical General.

1.2 WORK INCLUDED

A. The work under this section shall include all labor, materials, accessories, services and equipment necessary to furnish and install conductors, complete, as indicated on the Drawings and as specified herein. Provide a complete system of wiring with all feeders and branch circuits as shown on the Drawings. The wiring system shall be complete to each and every outlet and apparatus shown on the Drawings which requires electrical connections.

B. This section includes wires, cables, and connectors for power, lighting, signal, control and related systems rated 600 volts or less.

1.3 COLOR CODING

A. Color coding shall be as follows:

120/208 Volt System	**277/480 Volt System**
Phase A –Black	Phase A - Brown
Phase B – Red	Phase B - Orange
Phase C – Blue	Phase C - Yellow
Neutral – White	Neutral - Gray
Ground – Green	Ground - Green

(Verify color-coding with local code Authority and use local code requirements if and only if the above color code is not acceptable to local authority.)

B. All wire shall be color coded throughout its entire length. Colored phase tape is not allowed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Wire shall be Southwire, General Cable, Encore or approved equal.

2.2 CONDUCTORS

A. Conductor Material: Unless noted otherwise, conductors shall be copper, 99% conductivity except where specifically noted otherwise on Drawings.

B. All wire and cable for feeders and branch circuits shall have copper conductors and shall be 600 volts, 90 degrees C, NEC type conductors with THHN/THWN-2/XHHW-2 insulation.

C. Wire No. 8 AWG and larger shall have stranded conductors. Wire No. 10 AWG and smaller shall be solid conductor type.

D. No conductor shall be smaller than No. 12 AWG unless otherwise specified or noted. For wiring within dwelling units, No. 14 AWG is allowed for 15-amp circuits, unless prohibited by the authority having jurisdiction.

E. Branch circuit wiring which supplies more than one fluorescent fixture through the wiring of other fixtures shall be high temperature wire approved for such use.

F. Pulling lubricant is neither required nor allowed for Southwire/SIMpull™ or Encore SuperSlick conductors.

G. Nonmetallic-Sheathed Cable

1. NM cable shall be permitted in one-, two- and multi-family dwellings for building construction types III, IV and V, and where permitted by the local authority.
2. NM cable shall be permitted in other structures of types III, IV, and V construction provided that it is concealed within walls, floors, and/or ceilings that provide a thermal barrier of material that has at least a 15-minute finish rating as identified in listings of fire-rated assemblies.
3. NM cable shall not be installed in areas such as attic spaces within a clubhouse building which do not meet the thermal barrier criteria listed above or in portions of a building defined as assemblies per NEC article 518 with an occupant load of 100 or more people.

2.3 ALUMINUM CONDUCTORS

A. Where substituted for copper conductors, aluminum conductors shall match or exceed copper ampacity.

B. Aluminum conductors shall be compact, AA-8000 series.

C. Aluminum conductors shall not be used for branch circuits, and shall not be installed to any vibrating equipment (e.g. mechanical equipment, transformers, elevators, fire pumps). Minimum rating of feeder size shall be 100 amps.

D. Mechanical screw-type connectors shall comply with the following:

1. Connectors shall be dual rated (AL7CU or AL9CU) and listed by UL for use with aluminum and copper conductors and sized to accept aluminum conductors of the ampacity specified.
2. Using a suitable stripping tool, to avoid damage to the conductors, remove insulation from the required length of the conductor.
3. Wire brush the conductor and apply a listed joint compound.
4. Terminations: Terminations shall be performed using the manufacturers recommended tools, hardware, and procedures. Bolted terminations shall be bolted to torque levels in accordance with equipment manufacturers published data utilizing a torque wrench that has been calibrated and is appropriate for the application. In the absence of connector or equipment manufacturer's recommended torque values, use those specified in UL 486A and UL 486B.
5. Wipe off any excess joint compound.

E. For connection to aluminum bus, the following hardware shall be used:

1. Bolts: Anodized alloy 2024-T4 and conforming to ANSI B18.2.1 and to ASTM B211 or B221 chemical and mechanical property limits.
2. Nuts: Aluminum alloy 6061-T6 or 6262-T9 and conforming to ANSI B18.2.2.
3. Washers: Flat aluminum alloy 2024-T4, Type A plain, standard wide series conforming to ANSI B27.2.
4. Terminations: Terminations shall be performed using the manufacturers recommended tools, hardware, and procedures. Bolted terminations shall be bolted to torque levels in accordance

with equipment manufacturers published data utilizing a torque wrench that has been calibrated and is appropriate for the application. In the absence of connector or equipment manufacturer's recommended torque values, use those specified in UL 486A and UL 486B.

F. For connection to copper bus, the following hardware shall be used:

1. Bolts: Plated or galvanized medium carbon steel; heat treated, quenched and tempered equal to ASTM A-325 or SAE grade 5.
2. Nuts: Heavy semi-finished hexagon, conforming to ANSI B18.2.2, threads to be unified coarse series (UNC), class 2B.
3. Washers: Should be steel, Type A plain standard wide series conforming to ANSI B27.2.
4. Belleville conical spring washers: shall be of hardened steel, cadmium plated or silicone bronze.
5. Terminations: Terminations shall be performed using the manufacturers recommended tools, hardware, and procedures. Bolted terminations shall be bolted to torque levels in accordance with equipment manufacturers published data utilizing a torque wrench that has been calibrated and is appropriate for the application. In the absence of connector or equipment manufacturer's recommended torque values, use those specified in UL 486A and UL 486B.

G. Aluminum conductors shall not be used where expressly forbidden by the local electrical inspections department or plan review board of jurisdiction. The electrical contractor shall verify this requirement prior to bid.

H. Aluminum conductors shall not be connected to equipment which is not UL Listed for aluminum.

I. Service entrance cable, Type SE (THHN/THWN-2/XHHW-2), Style SER, 600 volt, aluminum alloy shall be permitted as unit panel feeder in multifamily dwellings.

2.4 METAL CLAD "MC" CABLE

A. Where allowed by the authority having jurisdiction, the use of metal clad cable is permitted as described below and shall meet all the requirements of the following codes and standards:

1. Underwriters Laboratories Inc. 44, 83, 1479, 1569, 1581, 2556
2. National Fire Protection Association NFPA 70, Article 330
3. All local codes and municipal ordinances.

B. The conductors of the metal clad cable shall comply with Articles 1.03 and 2.02 of this same section.

C. Unless noted otherwise on drawings, MC cable shall be limited to branch circuits concealed in walls, above ceilings and within electrical rooms. For MC cable circuits powered from a surface-mounted panelboard, cable homeruns shall be installed to a metal wireway above the panelboard, and conductors (without armor) shall be routed within metal conduit(s) from wireway to panelboard. Ampacity adjustment factors are not necessary for conduit lengths of 24" or less.

D. MC cable shall not be allowed for wiring to mechanical equipment, except for within the dwelling units.

E. Unless noted otherwise, the metal clad cable shall be **MC** with either a galvanized steel jacket or aluminum interlocked armor, a UL 1569 binder tape, with either a green insulated grounding conductor or MCI-A type cable with interlocked armor that is listed and identified for grounding, and rated for a maximum of 600 volts.

F. Where indicated, the metal clad cable shall be a **Jacketed Metal Clad and Parking Deck Cable** with a black or gray PVC covering, using solid copper conductors, a Mylar assembly covering tape, rated at 90 degrees centigrade, with a green insulated grounding conductor and rated for a maximum of 600 volts.

G. Refer to National Electrical Code Article 330 for uses not permitted.

H. Cables installed in other than vertical runs through bored or punched holes in wood or metal framing members, or through notches in wooden framing members and protected by a steel plate at least 1/16 inches thick, shall be considered supported and secured where such support does not exceed six (6) feet intervals.

I. Cables containing four or fewer conductors sized not larger than No. 10 AWG shall be secured within 12 inches of every box, cabinet, fitting or other cable termination.

J. Metal clad cable (Type MC), where installed in wet and damp locations, shall be rated for the condition of use and by written authorization from the project Engineer.

2.5 ACCESSORIES

A. Wire Joints: T & B "Sta-Kon," Scotchlok Type "R," Ideal No. 452 or 453, or Buchanan "B-Cap."

B. Cable Connectors: Solderless Type O.Z. "circular clamp type" or T & B "lock-tite" appropriate for the particular application involved.

PART 3 - EXECUTION

3.1 PREPARATION

A. Lubricant: No grease, oil or lubricant other than powdered soapstone or approved pulling compound shall be used to facilitate the pulling of wires. Lubricant shall not be used for conductors with SIMpull™ insulation.

3.2 INSTALLATION

A. Complete electrical systems shall be provided as shown on the Drawings and/or as specified herein.

B. Wires shall be pulled without excessive strain to prevent damage to conductor or insulation. Provide pull boxes as required to facilitate pulling of wire.

C. Prior to energizing, all service and feeder cables shall be tested with megohm meter to determine insulation resistance levels. Test report shall be submitted to the Engineer.

D. Each raceway indicated by symbol on Drawings shall contain three (3) No. 12 AWG wires unless otherwise noted, scheduled or indicated. Hatch marks on raceway symbols indicate the number of conductors in a raceway when the number exceeds three (3).

E. At each fixture or device outlet, a loop or end of wire not less than 6" long shall be left for connection to fixture or device.

F. Splices, taps and connections shall be made up as follows:

1. Wire sizes No. 10 AWG and smaller with wire nuts.

2. Wire and cable of sizes No. 8 AWG and larger, with insulated mechanical or crimped connectors.

G. Perform conductor tests as described in Section 26 00 00 - Electrical General.

END OF SECTION

SECTION 26 05 26

GROUNDING

PART 1 - GENERAL

1.1 DESCRIPTION

A. The work required under this section of the Specifications consists of furnishing, installation and connections of the building grounding system. Exterior branch circuit wiring and feeder conductors extended beyond the building are included. The building electrical system shall be 3-phase, 4-wire grounded wye system supplemented with equipment grounding system. Equipment grounding system shall be established with equipment grounding conductors; the use of metallic raceways for equipment grounding is not acceptable.

1.2 REGULATORY REQUIREMENTS

A. Install a complete grounding system in accordance with the National Electrical Code.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Provide all materials under this section of the specifications.

B. All materials shall be new, UL Listed, and bear a UL Label.

C. Refer to Section 26 05 19 - Conductors for conductor specification.

2.2 GROUNDING CONDUCTORS

A. Grounding electrode conductor shall be bare or green insulated copper conductor sized as indicated on the Drawings.

B. Equipment grounding conductors shall be green insulated conductors sized as indicated on the Drawings. Where size is not indicated on the Drawings, conductor size shall be determined from the National Electrical Code table on sizes of equipment grounding conductors.

C. Bonding jumpers shall be flexible copper bonding jumpers sized in accordance with the National Electrical Code tables for grounding electrode conductors.

2.3 PANELBOARDS, TRANSFORMERS, AND DISCONNECT SWITCHES

A. Provide each low voltage distribution and branch circuit panelboard with a copper equipment grounding bar brazed or riveted to the associated enclosures or cabinet and an insulated neutral bar.

B. Provide a conductor termination grounding lug bonded to the enclosure of each equipment item.

2.4 DEVICES

A. Each receptacle and switch device shall be furnished with a grounding screw connected to the metallic device frame.

2.5 GROUND RODS

A. Ground rods shall be 3/4" x 10'-0" copper clad steel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Ground all non-current carrying parts of the electrical system including raceways, equipment frames and enclosures, outlet boxes, junction boxes, and other conductive material in close proximity with electrical circuits.

B. Service entrance and separately derived electrical systems, grounding electrode system

1. The grounded conductor(s) of the electrical service serving the premises wiring system shall be connected to the neutral bus bar in the service equipment which shall be grounded to the cold water system, the ground rod system, and other grounding electrodes specified herein or indicated on the Drawings. Grounding electrode conductors shall be installed rigid, nonmetallic conduit to point of ground connection, unless subject to physical damage in which case it shall be installed in galvanized rigid steel.
2. Make connection to main water line entering the building. Make connections ahead of any valve or fittings whose removal may interrupt ground continuity.
3. Bond together the following systems to form the grounding electrode system. All system connections shall be made to the electrodes as close as possible to the service entrance equipment and each connected at the service entrance equipment neutral bus. Do not connect electrode systems together except at neutral bus.
   a. Cold water piping system
   b. Ground rod system
   c. Rebar in concrete footing
   d. Structural steel metal building frame
4. Ground the neutral of all dry type transformers to either building steel or a common grounding electrode conductor connected to a service ground. Transformers shall be bonded to the nearest available point on the interior water piping system. In reinforced concrete structures building steel shall be considered to be reinforcing steel of vertical columns.
5. Grounding electrode connections to structural steel, reinforcing bars, ground rods, or where indicated on the Drawings shall be with chemical exothermic weld connection devices recommended for the particular connection type. Connections to piping shall be with UL Listed mechanical ground clamps.
6. Where there is more than one service to a building or interconnected buildings, services shall be connected by means of a grounding electrode conductor.
7. Bonding shall be in accordance with the National Electrical Code.
8. Install ground rods where indicated on the Drawings with the top of the ground rods 12 inches below finished grade.

C. Equipment Grounding Conductor

1. Grounding conductors for branch circuits are not shown on the Drawings; however, grounding conductors shall be provided in all branch circuit raceways and cables.
2. Grounding conductors for feeders are typically indicated on the Drawings and the raceway is sized to accommodate grounding conductor shown. Where grounding conductor size is not indicated on the Drawings, conductor shall be in accordance with the equipment grounding conductor table of the National Electrical Code.

D. Other Grounding Requirements

1. Each telephone backboard shall be provided with a No. 6 grounding conductor. When backboard is located in vicinity of electrical service equipment, the “point of grounding” of this conductor shall be the main cold water service with connections made ahead of any valves or joints. Remote backboards shall use building steel as “point of ground.” Terminate conductor by stapling to backboard.
2. At each building expansion joint flexible copper bonding jumpers shall be attached to building structure by chemical weld process. Install bonding jumpers in concealed locations that will not subject connections or jumpers to physical abuse. Install 100' on centers across expansion joints.

3.2 TESTING

A. Upon completion of the ground rod installation, the Contractor shall test the installation in accordance with the “Electrical Testing” section of Section 26 00 00 - Electrical General. Grounding resistance reading shall be taken before connection is made to the building cold water piping system. Ground resistance readings shall not be taken within 48 hours of rainfall.

END OF SECTION

SECTION 26 05 30

FIRESTOPPING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 26 shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the products and execution requirements relating to Firestopping for Electrical Systems.

C. Product specifications, general design considerations, and installation guidelines are provided in this document. Typical firestopping installation details will be provided on Drawings as an attachment to this document. If the bid documents are in conflict, the Drawings shall take precedence. The successful Contractor shall meet or exceed all requirements described in this document.

1.2 WORK INCLUDED

A. The work included under this Specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

B. The work shall include, but not be limited to the following:

1. Furnish and install all Firestopping Materials.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

A. Approved Firestopping manufacturer(s)

1. FlameStopper Thru-Wall Fitting - Wiremold Company (Firestop Devices)
2. Tremco Inc. (Firestop Cast in Place Sleeves, Caulks, QuickComm Sleeves, QuickComm Units, Pillows, Putty Pads, Outlet Box Inserts, Silicone, Composite Sheets, Collars, Devices)
3. STI Firestop Products (Firestop Devices, Putties, Caulks, Sealants, etc.)
4. Hilti (Putties, Caulks, Sealants, etc.)

2.2 TYPES OF PRODUCTS

A. Firestop Products

1. Intumescent Firestop Sealants and Caulks
2. Acrylic Firestop Sealant and Caulks
3. Silicone Firestop Sealants and Caulks
4. Cast in Place Devices
5. Firestop Putty, Putty Pads
6. Outlet Box Inserts
7. QuickComm Sleeves
8. TREMstop Straps

9. Firestop Collars
10. Wrap Strips
11. Firestop Mortar
12. Firestop Pillows
13. Accessories: Forming/Damming Materials: Mineral Wool, Backer Rod or other type as per manufacturer recommendation.

B. Firestop Devices

1. Thru-Wall Fitting (FlameStopper by Wiremold)
   a. The firestop device box shall be constructed of 16-gauge G90 steel.
   b. The firestop device intumescent block shall be constructed of a graphite base material with expansion starting at 375 degrees F and an unrestrained expansion between 6 to 12 times. The intumescent block shall be held securely by the box in order to prevent tampering and damage during installation.
   c. The firestop device shall have doors which can be adjusted to prevent materials from penetrating the device if the device is empty or completely full. The doors shall be constructed of 16-gauge G90 steel with No. 10-32 screws use to adjust opening size.
   d. The firestop device shall be available for 2" and 4" trade size EMT conduit.
   e. The firestop device shall be available in safety yellow powder coat, custom colors and an unpainted galvanized finish.
2. Fire Rated Cable Pathway (STI EZ-PATH)
   a. Fire rated cable pathway device modules shall be comprised of steel raceway with intumescent foam pads allowing 0 - 100% cable fill.
3. Tremco (QuickComm Unit) 24" x 12" or 34" x 18"
   a. Fire rated steel frame with an intumescent channel. UL Tested for large openings with 100% visual cable fill. UL Tested for Concrete Floors, Block Walls, Dry Walls and Hollow Core Floors.
4. Tremco (QuickComm Sleeve)
   a. Fire rated steel sleeve with an intumescent inner sleeve. UL Tested for Concrete Floors, Block Walls, Dry Walls, Hollow Core and Fluted Decks.

2.3 UL CLASSIFICATION

A. Thru-Wall Fitting: The firestop device for use in through-penetration firestop systems shall have been examined and tested by Underwriters Laboratories Inc. to UL1479 (ASTM E 814 & ASTM E 84).

B. Threaded, Smooth and Split-Sleeve Firestop Devices: Firestopping sealants and devices shall be used together as a firestop system. All firestop systems shall bear a UL Classification system number.

C. QuickComm Sleeve: Firestop Sleeve for use in through penetration firestop systems. Shall be tested by Underwriters Laboratories Inc. or a recognized Testing Laboratory for through penetration fire stopping applications.

D. QuickComm Unit: Intumescent Firestopping Unit for use in large openings for firestopping for cables, Fiber optic, Power Control, Telecommunications

1. Threaded Firestop System
   a. Block Wall - W-J-3049
   b. Dry Wall - W-L-3138

2. Threaded Firestop System (Vertical)
   a. Slab - F-A-3010
3. Smooth Firestop System
   a. Block Wall - W-J-3048
   b. Dry Wall - W-L-3137
4. Split-Sleeve Firestop System
   a. Block Wall - W-J-3047
   b. Dry Wall - W-L-3136
5. Tremco QuickComm Sleeve
   a. Block Wall- C-AJ-0123, C-AJ-2580, C-AJ-3270
   b. Dry Wall- WL-0025, WL-2418, WL-3318
   c. Concrete Floor- C-AJ-0123, C-AJ-2580, C-AJ-3270
   d. Fluted Deck- C-AJ-0123
   e. Hollow Core- C-AJ-0123, C-AJ-2580, C-AJ-3318
6. Tremco QuickComm Unit
   a. Dry Wall- WL-3319, WL-4070
   b. Concrete Floor- F-A-3035, F-A-4006

2.4 FIRESTOPPING SYSTEMS

A. Thru-Wall Fitting Firestop System

1. The device shall be classified for use in one-, two-, three-, and four-hour rated gypsum, concrete and block walls and provide an L rating of less than 5 cfm. The device shall also be tested by Underwriters Laboratories Inc. to UL2043 and determined to be suitable for use in air handling spaces.

B. Threaded, Smooth and Split-Sleeve Firestop Systems

1. Shall conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted test agencies per ASTM E814 and ASTM E 84 (UL 1479) fire tests in a configuration that is representative of field conditions.
2. The F rating must be a minimum of one (1) hour but not less than the fire resistance rating of the assembly being penetrated. T rating when required by code authority shall be based on measurement of the temperature rise on penetrating item(s). The fire test shall be conducted with a minimum positive pressure differential of 0.01 inches of water column.

C. Firestopping materials and systems must be capable of closing or filling through-openings created by the burning or melting of combustible pipes, cable jacketing, or pipe insulation materials.

D. Firestopping material shall be asbestos and lead free and shall not incorporate nor require the use of hazardous solvents.

E. Firestopping sealants must be flexible, allowing for normal pipe movement.

F. Firestopping materials shall not shrink upon drying as evidenced by cracking or pulling back from contact surfaces.

G. Firestopping materials shall be moisture resistant, and may not dissolve in water after curing.

H. Firestopping material shall be installed inside the cavity of the wall as shown by the annular space requirements in the UL Tested System.

PART 3 - EXECUTION

3.1 CONDITIONS REQUIRING FIRESTOPPING

A. General

1. Provide firestopping for conditions specified whether or not firestopping is indicated, and if indicated, whether such material is designed as insulation, safing, or otherwise.

B. Through-Penetrations

1. Firestopping shall be installed in all open penetrations and in the annular space in all penetrations in any bearing or non-bearing fire-rated barrier.

C. Membrane-Penetrations

1. Where required by code, all membrane-penetrations in rated walls shall be protected with firestopping products that meet ASTM E 814 and ASTM E 84 Test requirements.

D. Smoke-Stopping

1. As required by the other sections, smoke-stops shall be provided for through-penetrations, membrane-penetrations, and construction gaps with a material approved for the ASTM E 136 Standards.

3.2 EXAMINATION

A. Examine the areas and conditions where firestops are to be installed and notify the Architect of conditions detrimental to the proper and timely completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.

B. Verify that environmental conditions are safe and suitable for installation of firestop products.

C. Verify that all pipes, conduit, cable, and other items that penetrate fire-rated construction have been permanently installed prior to installation of firestops.

3.3 INSTALLATION

A. General

1. Through Penetration firestop submittals showing each UL Rated Assembly shall be located in the general Contractor’s trailer for Inspection purposes.
2. Installation of firestops shall be performed by an applicator/installer qualified and trained by the manufacturer. Written documentation stating training done on the specific project shall be supplied to the General Contractor for inspection purposes. Installation shall be performed in strict accordance with manufacturer’s detailed installation procedures.
3. Apply firestops in accordance with UL Tested Systems, fire resistance requirements, acceptable sample installations, and manufacturer’s recommendations.
4. Unless specified and approved, all insulation used in conjunction with through-penetrants shall remain intact and undamaged and may not be removed.

5. Seal holes and penetrations to ensure an effective smoke seal. In areas of high traffic, protect firestopping materials from damage. If the opening is large, install firestopping materials capable of supporting the weight of a human.
   a. Insulation types specified in other sections shall not be installed in lieu of firestopping material specified herein.
   b. All combustible penetrants (e.g. non-metallic pipes or insulated metallic pipes) shall be firestopped using products and systems tested in a configuration representative of the field condition.

B. Dam Construction

1. When required to properly contain firestopping materials within openings, damming or packing materials may be utilized. Combustible damming material must be removed after appropriate curing. Noncombustible damming materials may be left as a permanent component of the firestop system.

3.4 FIELD QUALITY CONTROL

A. Preconstruction meeting shall take place to address firestopping systems to be installed.

B. Prepare and install firestopping systems in accordance with UL Tested System and manufacturer's printed instructions and recommendations.

C. Follow safety procedures recommended in the Material Safety Data Sheets.

D. Finish surfaces of firestopping that are to remain exposed in the completed work to a uniform and level condition.

E. All areas of work must be accessible until inspection by the applicable Code Authorities.

F. Correct unacceptable firestops and provide additional inspection to verify compliance with this Specification.

3.5 CLEANING

A. Remove spilled and excess materials adjacent to firestopping without damaging adjacent surfaces.

B. Leave finished work in a neat and clean condition with no evidence of spillovers or damage to adjacent surfaces.

END OF SECTION

SECTION 26 05 33

CONDUIT AND RACEWAYS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. This section covers the complete interior and exterior conduit system.

B. All work specified herein shall be accomplished in accordance with the applicable requirements of Section 26 00 00 - Electrical General.

1.2 STANDARDS

A. Industry Standards

1. Underwriters Laboratories Inc. (UL) Publications
   - No. 1: Standard for Flexible Metal Conduit
   - No. 6: Standard for Rigid Metal Conduit
   - No. 467: Standard for Grounding and Bonding Equipment
   - No. 651: Standard for Schedule 40 and 80 Rigid PVC Conduit
   - No. 797: Electrical Metallic Tubing - Steel
   - No. 1242: Standard for Electrical Intermediate Metal Conduit - Steel
2. American National Standards Institute (ANSI)
   - C-80.1: Rigid Galvanized Conduit
   - C-80.3: Electrical Metallic Tubing

1.3 WORK INCLUDED

A. The work under this section shall include all labor, materials, accessories, services and equipment necessary to furnish and install conduits and raceways, complete, as indicated on the Drawings and as specified herein.

B. Other manufacturers of equal quality and performance may be submitted to the Engineer for review. When substitution of equipment is made, the Contractor shall be responsible for the costs of any item and engineering and construction revisions necessary in his or any other contract or trade that may be required to satisfy plans and specifications.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Approved Manufacturers

1. Metallic Conduit Fittings
   a. Thomas and Betts
   b. Appleton
   c. RACO
   d. Crouse Hinds
   e. Steel City
2. Support Channel
   a. Unistrut
   b. Kindorf
3. Non-metallic Conduit Fittings
   a. Carlon
   b. Georgia Pipe Company
4. Rigid, IMC or Flexible Conduit
   a. Allied

b. Republic
c. Triangle
d. Wheatland
e. Youngstown
f. Southwire

5. Flexible Conduit (PVC Conduit)
   a. Anaconda "Sealtite"
   b. Robroy
   c. Southwire
6. Electrical Metallic Tubing
   a. Steeltubes
   b. National
   c. Wheatland
   d. Allied
   e. Triangle
   f. Youngstown
7. Plastic PVC
   a. Carlon
   b. Georgia Pipe Company
8. Pull Box Manufacturer(s)
   a. Hoffman
   b. OZ Gedney
   c. Or Approved Equal
9. Approved Marker Tape Manufacturer(s)
   a. William Frick & Associates
   b. Or Approved Equal
10. Approved Maintenance Hole/Handhole Manufacturer(s)
   a. Old Castle
   b. Pencell (Handholes Only)
   c. Quazite (Handholes Only)
   d. Or Approved Equal
11. Approved Conduit Plug/Cap Manufacturer(s)
   a. Jack Moon
   b. Or Approved Equal

2.2 CONDUIT FITTINGS

A. Electrical metallic tubing (EMT) couplings and connectors shall be steel. Malleable iron, pressure cast or die cast fittings are not permitted.

B. Fittings and couplings shall be set-screw type and/or compression type per 3.01 13. Steel set screw type for 2.5" conduit and larger shall have 2 screws for connectors and 4 screws for couplings. All connectors shall be insulated throat type.

C. Rigid steel and IMC couplings and connectors shall be standard threaded couplings, locknuts, bushings and elbows. All materials shall be steel. Erickson-type couplings may be used to complete a conduit run.

2.3 NON-METALLIC CONDUIT AND FITTINGS

A. Non-metallic conduit shall be heavy wall, Schedule 40 PVC. Electrical non-metallic tubing (ENT) shall be allowed within dwelling units.

B. Couplings and connectors for non-metallic conduit shall be of the same material and be the product of the same manufacturer of the conduit furnished.

C. PVC conduit for concrete encasement shall be Type EB, UL Labeled for 90 degrees C cables. Fittings shall be Type EB, solvent type, and from the same manufacturer as the conduit.

D. Concrete shall have a minimum strength of 2,500 psi at 28 days.

2.4 CONDUIT SUPPORT

A. Individual conduit hangers shall be galvanized spring steel specifically designed for the purpose and sized appropriately for the conduit type and diameter. Support individual conduits 1-1/2" and smaller with 1/4" threaded steel rods and use 3/8" rods for 2" and larger.

B. Conduit support channels shall be 14-gauge galvanized (or equivalent treatment) channel sized for the amount of conduit to be supported. Channel suspension shall be 3/8" threaded steel rods. Conduit straps shall be spring steel type compatible with channel.

C. Conduit straps shall be single-hole cast metal type or two-hole galvanized metal type. Conduit clamps shall be spring steel type for use with exposed structural steel.

2.5 RIGID METALLIC CONDUIT, INTERMEDIATE METALLIC CONDUIT, AND ELECTRICAL METALLIC TUBING

A. Rigid metallic conduit and intermediate metallic conduit shall be steel and standard thread.

B. Electrical metallic tubing (EMT) shall be steel.

2.6 RIGID METALLIC, INTERMEDIATE METALLIC, AND FLEXIBLE CONDUIT AND FITTINGS

A. Rigid metallic conduit and intermediate metallic conduit shall be steel and standard thread.

B. Flexible conduit shall be steel or aluminum type classified for system grounding.

C. Connectors for flexible conduit shall be insulated throat type rated as suitable for system ground continuity.

D. Flexible conduit used for other than connections to lighting fixtures shall not be less than 1/2" trade size. 3/8" flexible conduit may be used for connection to lighting fixtures when sized according to the National Electrical Code.

E. Flexible conduit used in damp or wet locations shall be liquid tight.

2.7 PULL BOXES

A. Pull boxes shall be constructed of galvanized steel with flat, removable covers fastened with plated steel screws.

B. Pull boxes shall be equipped with keyhole screw slots in the cover to permit removal of the cover without extracting the screws.

C. Pull boxes shall have provisions for grounding.

2.8 MAINTENANCE HOLES/HANDHOLES

A. Maintenance Holes

1. Maintenance holes shall be pre-cast or cast-in-place concrete with a strength of 3,500 psi at 28 days, and steel reinforced.

2. Maintenance holes shall include a cast iron frame with cover, a hot dipped galvanized steel ladder, and hot dipped galvanized pulling eyes embedded in the concrete opposite each duct entrance and in the floor beneath the cover.
3. Maintenance holes shall be equipped with grounding busbar.
4. Maintenance holes shall be equipped with racking for cable storage.
5. Ground splices and connections at maintenance holes shall be exothermic welds, copper or bronze compression ground fittings, or bolted compression ring lugs.
6. The cover for electrical maintenance holes shall have the lettering, “POWER” or “ELECTRIC.”
7. The cover for low voltage maintenance holes shall have the lettering, “COMMUNICATIONS.”

B. Handholes

1. Handholes shall be non-conductive and shall not require grounding for safety. Handholes shall be unaffected by freeze/thaw and resistant to sunlight and chemicals. Handholes shall be pre-cast polymer concrete, heavy duty rated and bottomless.
2. Handholes shall be equipped with racking for cable storage.
3. Electrical handholes shall have the word “POWER” or “ELECTRIC” molded in the cover by the manufacturer. The cover shall be attached with penta-head stainless steel bolts.
4. Low voltage handholes shall have the word “COMMUNICATIONS” molded in the cover by the manufacturer. The cover shall be attached with penta-head stainless steel bolts.
5. Handholes shall be able to withstand 10,000 lbs minimum.
6. See Drawings for handhole dimensions and locations.

2.9 CONDUIT PLUGS/CAPS

A. Conduit Plugs/Caps

1. Conduit plugs shall provide a watertight seal at exposed ends of conduits.
2. Conduit plugs shall be conduit size specific.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General

1. Minimum size for electrical conduits shall be 1/2" trade size.
2. Minimum size for low voltage conduits shall be 3/4" trade size.
3. Conceal all conduits, except in unfinished spaces such as equipment rooms or as indicated by symbol on the drawings.
4. Leave all empty conduits with a 200 pound test nylon cord pull line.
5. Flattened, dented, or deformed conduits are not permitted and shall be removed and replaced.
6. Fasten conduit support device to structure with wood screws on wood, toggle bolts on hollow masonry, anchors as specified on solid masonry or concrete, and machine bolts, clamps, or spring steel clips, on steel.
7. Protect conduits against dirt, plaster, and foreign debris with conduit caps or plugs, which shall remain in place until all masonry is complete. Protect conduit stub-ups during construction from damage; any damaged conduits shall not be used and are to be replaced.
8. All feeder conduits shall be cleared of any dirt, foreign debris, etc.
9. Install conduit with wiring, including homeruns as indicated on the drawings. Any change resulting in a savings in labor or materials is to be made only in accordance with a Contract change. Deviations shall be made only where necessary to avoid interferences and when approved by Engineer by written authorization.
10. Conduits which penetrate roof membranes shall be installed in accordance with manufacturer’s recommendations and architectural specifications.

11. Seal all conduits entering building from below grade, all conduits entering refrigerated spaces i.e. freezers and coolers, and all conduits entering exterior mounted electrical equipment with insulating electrical putty to prevent entrance of moisture.
12. Separate raceway systems are to be installed for power systems and for control, signal and communications systems. Do not install control, signal or communications cables in the same raceways as branch circuit or feeders cables, unless indicated otherwise on the drawings.
13. Conduit fittings shall be set screw type for dry, indoor environments. Conduit fittings shall be gland and ring compression type for all conduit exposed to outdoor environments or wet locations.
14. Conduit shall be run parallel or at right angles to walls, ceilings, and structural members.
15. Support conduits at intervals not exceeding ten feet and within three feet of each outlet, junction box, fitting, panelboard, enclosure or cabinet. Support conduits from structural steel members with spring steel type or beam conduit clamps and to non-metallic structural members with one-hole conduit straps. For exposed conduits and where conduits must be suspended below structure, single conduit runs shall be supported from structure by hanger rod and conduit clamp assembly, and multiple conduits shall be supported by trapeze type support suspended from structure. Do not attach conduits to ceiling suspension system channels or suspension wires.
16. Attach feeder conduits larger than one inch trade diameter to or from structure on intervals not exceeding twelve feet with conduit beam clamps, one-hole conduit straps or trapeze type support.
17. Where conduits must pass through structural members obtain approval of Architect.
18. Install all conduits or sleeves penetrating or routed within rated fire walls or fire floors to maintain fire rating of wall or floor. Conduit shall not be installed in rated floors or walls if it compromises or violates the fire rating of floor or wall. Refer to architectural documents.
19. Provide expansion and deflection coupling where conduit passes over a building expansion joint.
20. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot water pipes. Install horizontal raceway runs above water and steam piping.
21. Telephone and signal system raceways: 2" trade size and smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.
22. Conduit shall be installed for feeders on the supply side of any panelboard(s) supplying branch circuits for pools, spas or hot tubs.

B. Uses Permitted

1. Conduits installed within concrete floor slabs shall be galvanized rigid steel (GRS), intermediate metal conduit (IMC), Schedule 40, heavy wall PVC, or electrical non-metallic tubing (ENT).
2. Conduit run exterior exposed: Galvanized rigid steel (GRS) or intermediate metal conduit (IMC).
3. Conduits in direct contact with earth shall be Schedule 40, heavy wall PVC. Elbows for underground conduits greater than 200' in length shall be galvanized rigid steel (GRS), or electrical metallic tubing (EMT) if elbows are concrete encased. Service entrance conduits installed exposed, or concealed in walls or above ceilings, shall be galvanized rigid steel (GRS) or intermediate metal conduit (IMC). Unless indicated otherwise, service entrance conduits shall be installed “outside” of the building as defined by the NEC. Provide concrete encasement where required or as indicated on drawings.
4. All other conduit, unless specified herein, not permitted in accordance with the NEC, or otherwise indicated on the drawings, shall be electrical metallic tubing (EMT). PVC conduit is not allowed in exposed or concealed areas, but only within concrete or below grade. Feeder or branch circuit conduits that emerge from a floor slab in an exposed location shall be galvanized rigid steel (GRS), electrical metallic tubing (EMT) or intermediate metal conduit (IMC). Where conduits emerge from a floor slab in a concealed location (a wall cavity or above ceiling), PVC elbows are permitted, provided that a conduit adaptor for steel conduit is installed at the nearest point at the slab.
5. Use flexible conduit for connections to motors, dry type transformers, electrical duct heaters, unit heaters, kitchen equipment, laundry equipment, flush mounted lighting fixtures, and any vibrating equipment.
    a. Flexible conduit used for connection of motors, dry type transformers, electric duct heaters, unit heaters, and bus duct tap devices shall not exceed 36 inches in length.
    b. Flexible conduit from outlet box to flush mounted lighting fixture shall not exceed 6 feet in length.

c. Maintain ground continuity through flexible conduit with green equipment grounding conductor; do not use flexible conduit for ground continuity.
d. Flexible conduit installed within plenum spaces shall be limited to lengths not exceeding 4 feet.
e. Liquid tight flexible conduit shall be used to connect equipment in exterior, damp or wet locations.

6. All conduit from the fire pump controller to the fire pump shall be either galvanized rigid steel (GRS) or liquid tight flexible conduit.

C. Below Grade Raceway Installations

1. Install top of conduits 2 inches minimum below bottom of building slabs.

D. Raceway Installations within Concrete

1. Conduit shall be run following the most direct route between points.
2. Conduit shall not be installed in concrete where the outside diameter is larger than 1/3 of the slab thickness.
3. Conduits shall not be installed within shear walls unless specifically indicated on the drawings. Conduit shall not be run directly below and parallel with load bearing walls.
4. Protect all conduits entering and leaving concrete floor slabs from physical damage during construction.
5. Provide expansion fittings in all conduits that pass through building expansion joints.

3.2 PULL BOXES

A. Pull boxes shall be secured, independent of the conduit entries into the box. Pull boxes shall be secured to the building structure. In ceiling applications, pull boxes shall not be supported with ceiling wires.

B. Conduits entering pull boxes shall connect to pull boxes using die-cast zinc connectors.

C. Pull boxes shall be free from burrs, dirt and debris.

3.3 MAINTENANCE HOLES/HANDHOLES

A. Maintenance holes/handholes shall be installed on a base of pea gravel at least 12 inches deep.

B. Tops of maintenance holes/handholes shall be level with the existing grade.

C. Ducts should enter as perpendicular to the wall surface as possible.

D. Maintenance holes shall be grounded with four 3/4 inch diameter by 8 foot long ground rods, one driven inside of the maintenance hole at each corner. Connect the ground rods and any duct bank ground conductors together with a No. 4/0 AWG bare, stranded copper ground wire loop. A No. 2 AWG bare stranded copper pigtail from the ground wire loop shall be used to ground the maintenance hole cover frame, ladder support bracket, any metallic concrete inserts and metallic cable racks, and the shields of any cables that are spliced in the maintenance hole.

3.4 CONDUIT PLUGS/CAPS

A. Protect conduits against dirt, plaster, and foreign debris with conduit plugs. Plugs shall remain in place until ready for use.

B. Simplex, triplex or quadplex duct plugs shall be installed in conduits to house and seal cables.

END OF SECTION

SECTION 26 05 34

OUTLET BOXES AND JUNCTION BOXES

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. All work specified herein shall be accomplished in accordance with the applicable requirements of Section 26 00 00 - Electrical General.

1.2 WORK INCLUDED

A. The work under this section shall include all labor, materials, accessories, services and equipment necessary to furnish and install outlet and junction boxes, complete, as indicated on the Drawings and as specified herein.

B. Equipment schedules and specifications are based on the one manufacturer listed in the schedule. Other manufacturers of equal quality and performance may be submitted to the Engineer for review. When substitution of equipment is made the Contractor shall be responsible for the costs of any item and engineered and construction revisions necessary in his or any other contract or trade that may be required to satisfy plans and specifications.

1.3 QUALITY ASSURANCE

A. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.

C. Nonmetallic Outlet and Device Boxes: NEMA OS 2.

D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

E. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.

F. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic, finished inside with radio-frequency-resistant paint.

G. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

1.4 JOB CONDITIONS

A. Protection: Anchor boxes securely to formwork. Provide necessary protection to prevent entry of concrete.

B. Sequencing, Scheduling: Locations of outlets shown on the Drawings are relative and approximate. Exact locations shall be determined on the job and the outlets accurately set according to the

architectural drawings, dimensions, casework kneespace, building conditions, furniture positions and Architect's direction. The right is reserved to change the exact location (10'-0" or less) of any switch, ceiling outlet or other outlet in any room before it is permanently installed without increase in Contract cost.

C. All outlet boxes and junction boxes shall be accessible. Any boxes in non-accessible areas (furred ceilings) shall be set flush with barrier surface at a location approved by the Architect.

D. All outlet boxes and junction boxes installed in a wall or ceiling that is part of the building's thermal envelope shall meet NEMA OS-4 requirements and maintain the integrity of the envelope.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Thomas & Betts/Steel City, Pass & Seymour or equal.

2.2 OUTLET BOXES

A. Standard Outlet Boxes: Boxes and covers shall be thermo plastic or phenolic and rated according to the space it occupies, of such form and dimensions as to be adapted to its specific use and location, kind of fixtures to be used and number, size and arrangement of conduits connecting thereto and particularly sized to accommodate the number and size of wires to be contained therein.

B. Ceiling outlet boxes shall be 1-1/2" or 3-3/8" deep, 4" octagonal (or 4" square when required due to number of wires). Plaster rings or device covers need not be provided on ceiling boxes. Provide extension rings on ceiling boxes to accommodate number of conductors in box.

C. Wall outlet boxes for toggle switches and convenience outlets shall be 1-1/2" or 2-1/8" deep, 4" or 4-11/16" square. Provide with single-device covers (or two-device covers where needed). Covers shall be raised type to compensate for thickness of plaster or gypsum board wall finish.

D. Outlet boxes for telecommunication purposes (telephone, data, etc.) shall be 4" x 4" square, 2-1/8" deep. Provide with single device covers (or two-device covers where needed). Covers shall be raised type to compensate for thickness of plaster or gypsum board wall finish.

E. Junction boxes shall be as specified for ceiling and wall outlet boxes. Provide flat covers on ceiling outlets to match ceiling finish. Provide blank device type coverplates on wall outlets, of same materials as specified for device coverplates in same room or area.

F. Outlet boxes where exposed rigid conduit is used shall be cast ferrous alloy, galvanized or cast aluminum.

G. Covers: Where outlet boxes are to be capped, blank coverplates shall be used.

H. Barriers: Provide barriers between devices operating at different voltages or on separate systems such as normal, critical, or life safety.

2.3 FLOOR BOXES

A. Product Description

1. Floor boxes for receptacles and telephone/data outlets shall be round. Boxes shall include a non-metallic concrete cover to prohibit concrete or debris from entering the box during installation.
2. Floor boxes for use in slab on grade installations shall be non-metallic PVC and be suitable for use in slab on grade conditions.
3. Floor boxes for use in above grade installations shall be metallic and suitable for use in concrete slabs above grade.
4. Provide number of compartments as indicated on drawings.
5. Coverplates and flanges shall be brass.
6. Floor box device covers shall meet UL 514C requirements for scrubwater test standards.

B. Manufacturer

1.	Hubbell	RF400 Series (Non-Metallic) B252 Series (Metallic)
1.	Wiremold	862 Series (Non-Metallic) 885 Series (Metallic)
2.	Thomas & Betts	68P Series (Non-Metallic)

C. For poke-thru devices, refer to 2.04 D of Section 26 27 26 - Wiring Devices.

2.4 PULL AND JUNCTION BOXES

A. Pull and Junction boxes are not completely indicated. They shall be sized and installed where required in accordance with the NEC.

B. Pull and Junction Boxes shall be the suitable NEMA type number to match the environmental conditions.

C. Locations of concealed pull and junction boxes shall be indicated on the record as build drawings for Owner's record.

2.5 CABINETS, FITTINGS, BOXES: GENERAL

A. Cabinets shall be in accordance with UL 50, "Electrical Cabinets and Boxes" and NEMA 250, Type 1. Electrical cabinets, boxes and fittings shall be as required for types, sizes, and NEMA enclosure classes. Where not indicated, provide units of types, sizes, and classes appropriate for the use and location. Provide all items complete with covers and accessories required for the intended use. Provide gaskets for units in damp or wet locations.

B. Construction shall be sheet steel, NEMA 1 class except as otherwise indicated. Cabinets shall consist of a box and a front consisting of a 1-piece frame and a hinged door. Arrange door to close against a rabbet placed all around the inside edge of the frame, with a uniformly close fit between door and frame. Provide concealed fasteners, not over 24" apart, to hold fronts to cabinet boxes and provide for adjustment. Provide flush or concealed door hinges not over 24" apart and not over 6" from top and bottom of door. For flush cabinets, make the front approximately 3/4" larger than the box all around. For surface mounted cabinets make from same height and width as box. Furnish metal barriers to separate wiring of different systems and voltage, and furnish accessory feet where required for freestanding equipment.

C. Fasteners for general use shall be corrosion resistant screws and hardware including cadmium and zinc plated items.

D. Fasteners for damp and wet locations shall be stainless steel screws and hardware.

E. Exterior finish shall be gray baked enamel for items exposed in finished locations except as otherwise indicated.

F. Painted interior finish, where indicated, shall be white baked enamel.

G. Fittings for boxes, cabinets, and enclosures shall be in accordance with UL 5148 and shall be zinc plated steel for conduit hubs, bushings, and box connectors.

2.6 UNDERGROUND PULL/JUNCTION BOXES

A. Unless noted otherwise, underground enclosures shall be fiberglass, open-bottom and sloped-wall. Covers shall be polymer concrete. Boxes shall be installed in areas expected to experience only light incidental, non-deliberate vehicular traffic (including that from mowers).

B. Enclosures shall meet the load requirements and three-point test procedures specified in the industry standard ANSI SCTE 77 2007. Enclosures shall meet the Tier 8 cover load test (for light traffic) of 12,000 lbs. over a 10" x 10" plate.

C. Manufacturer’s guidelines shall be followed for installation, including 6" gravel bed beneath box for stability and drainage. Concrete collar shall be poured around enclosure to protect the ring and top from impact due to soil erosion.

D. Maunfacturer

1. Highline Products
2. OZ-Gedney

PART 3 - EXECUTION

3.1 INSPECTION

A. The location of all wall outlets, including light fixtures, receptacles, switches, etc., shall be checked to see that the outlet will clear any wall fixture, shelving, work tables, sinks, baseboard and fin type convectors, bulletin boards, etc., that will be installed.

B. Exact locations of outlet boxes shall be coordinated with other trades so that outlet will not be covered by ductwork, piping, etc.

C. The approximate locations of outlets are indicated on the Drawings. The exact locations shall be determined at the building. The right is reserved to change, without additional cost, the exact location of any outlet, a maximum of 10' before it is permanently installed.

3.2 PREPARATION

A. Architectural Placement: Outlets occurring in architectural features shall be accurately centered in same. Space wall switch outlets equidistant from door trims on the strike side of doors as actually

installed so that coverplate clears trim. Orientation of outlet boxes (horizontal or vertical) shall be as indicated on architectural elevations.

B. Install all outlet boxes in finished areas flush with wall or ceiling finish. Maintain 1/4" or less space between outlet box front and finish wall surface.

C. All switches at same level shall be installed on one horizontal line as shown on the Drawings.

D. Wall mounted controls, including temperature controls, in a room shall be grouped at the same location and at same mounting heights.

3.3 INSTALLATION

A. At all concealed outlets for electric lights, switches, wall receptacles, etc., standard outlet boxes and plaster rings shall be provided.

B. Outlet boxes shall be firmly anchored in place and shall be provided with approved fixture studs where required. Outlet boxes shall not depend on the coverplate to hold it secure to the wall.

C. Boxes on opposite sides of walls or partitions: Where drawings show back-to-back wiring devices, the devices on opposite sides of the wall shall be offset a minimum of 6". Through-the-wall type boxes shall not be used. Where boxes will be located on opposite sides of walls or partitions located 24" or closer to each other, moldable putty pads shall be installed to completely cover the exterior surfaces of the box within the stud cavity with a ball of putty material used to plug the end of each conduit at its connection to the box.

D. All holes cut through new or existing smoke or fire partitions shall be sealed. Sealant shall be 3M Brand Fire Barrier System or approved equal. Seals shall be installed in accordance with manufacturer’s recommendations.

E. All flush boxes in rated walls that are larger than 16 square inches in area shall be backed as follows: 1-hour wall - 1 layer of 5/8" gypsum board; 2-hour rated wall - 2 layers of 5/8" gypsum board. Gypsum shall be fire code and attached to outside surfaces of box(es).

F. Cast aluminum, threaded hub type boxes with gasketed weatherproof covers shall be used for wet locations where box is surface mounted.

G. Location of floor boxes indicated is approximate. The Contractor shall refer to the final furniture layout or request field instructions for the exact location. Consult the Architect prior to installation.

H. For outlet and junction boxes installed within grout-filled walls, boxes shall be sealed externally with duct tape to prevent entry of concrete into boxes.

END OF SECTION

SECTION 26 09 23

OCCUPANCY SENSORS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. The Contractor's work shall include all labor, materials, tools, appliances, control hardware, sensor, wire, junction boxes and equipment necessary for and incidental to the delivery, installation and furnishing of a completely operational occupancy sensor lighting control system, as described herein.

B. The Contractor/supplier shall examine all general specification provisions and drawings for related electrical work required as work under Division 26.

C. The Contractor shall coordinate all work described in this section with all other applicable plans and specifications, including but not limited to wiring, conduit, fixtures, HVAC systems and building management systems.

1.2 EQUIPMENT QUALIFICATION

A. Products supplied shall be from a single manufacturer that has been continuously involved in the manufacturing of occupancy sensors for a minimum of five (5) years. Mixing of manufacturers shall not be allowed.

B. All components shall be UL Listed, offer a 5-year warranty and meet all state and local applicable code requirements.

C. Products shall be manufactured by an ISO 9002 certified manufacturing facility and shall have a defect rate of less than 1/3 of 1%.

D. Wall switch products must be capable of withstanding the effects of inrush current. Submittals shall clearly indicate the method used.

1.3 SYSTEM DESCRIPTION

A. The objective of this section is to ensure the proper installation of the occupancy sensor based lighting control system so that lighting is turned off automatically after reasonable time delay when a room or area is vacated by the last person to occupy said room or area.

B. The occupancy sensor based lighting control shall accommodate all conditions of space utilization and all irregular work hours and habits.

C. The Contractor shall warrant all equipment furnished in accordance to this specification to be undamaged, free of defects in materials and workmanship, and in conformance with the specifications. The supplier's obligation shall include repair or replacement, and testing without charge to the Owner, all or any parts of equipment which are found to be damaged, defective or non-conforming and returned to the supplier. The warranty shall commence upon the Owner's acceptance of the project. Warranty on labor shall be for a minimum period of one (1) year.

1.4 SUBMITTALS

A. Manufacturer shall substantiate conformance to this specification by supplying the necessary documents, performance data and wiring diagrams. Any deviations to this specification must be clearly stated by letter and submitted.

B. Submit a lighting plan clearly marked by manufacturer showing proper product, location and orientation of each sensor.

C. Submit any interconnection diagrams per major subsystem showing proper wiring.

D. Submit standard catalog literature which includes performance specifications indicating compliance to the specification.

E. Catalog sheets must clearly state any load restrictions when used with electronic ballasts.

1.5 SYSTEM OPERATION

A. It shall be the Contractor's responsibility to make all proper adjustments to assure Owner's satisfaction with the occupancy system.

1.6 ACCEPTABLE MANUFACTURERS

A. The Watt Stopper, or Pre-Approved Equal: For pre-approval, provide all the information listed under section 1.04 A and 1.04 D a minimum of ten (10) working days prior to initial bid date.

B. The listing of any manufacturer as "acceptable" does not imply automatic approval. It is the sole responsibility of the electrical contractor to ensure that any price quotations received and submittals made are for sensors which meet or exceed the specifications included herein.

PART 2 - PRODUCTS

2.1 GENERAL

A. All products shall be Watt Stopper product numbers.

1. Ceiling sensors: CI-300, CI-305, CI-355, CX-100, CX-105, DT-200, DT-205, DT-300, DT-305, DT-355, UT-300, UT-305, UT-355, WPIR, WT-605, WT-600, WT-1105, WT-1100, WT-2205, WT-2200, WT-2250, WT-2255

2. Wall switch sensors: DSW-100, DSW-200, DSW-301, DSW-302, DW-100-24, DW-311, PW-100, PW-100-24, PW-200, PW-301, PW-302, PW-311, UW-100, UW-100-24, UW-200

3. Power and Auxiliary Packs: BZ-50, BZ-150, BZ-200, BZ-250, C120E-P, C277E-P, S120/27-P

4. HID Control: DM-105

5. Outdoor sensors: EW-200, EW-205-24

6. Low Temperature: CB-100

7. Digital Time Switches: TS-400, TS-400-24

8. Automatic Control Switch: AS-100

B. Wall switch sensors shall be capable of detection of occupancy at desktop level up to 300 square feet, and gross motion up to 1000 square feet.

C. Wall switch sensors shall accommodate loads from 0 to 800 watts at 120 volts; 0 to 1,200 watts at 277 volts and shall have 180 degrees coverage capability.

D. Wall switch products shall utilize Zero Crossing Circuitry, which increases relay life, protects from the effects of inrush current, and increases sensor's longevity.

E. Wall switch sensors shall have no leakage current to load, in manual or in Auto/Off mode for safety purposes and shall have voltage drop protection.

F. Where specified, wall switch sensors shall provide a field selectable option to convert sensor operation from automatic-ON to manual-ON.

G. Where specified, vandal resistant wall switch sensors shall utilize a hard lens with a minimum 1.0 mm thickness. Products utilizing a soft lens will not be considered.

H. Passive infrared sensors shall utilize Pulse Count Processing and Digital Signature Analysis to respond only to those signals caused by human motion.

I. Passive infrared sensors shall utilize mixed signal ASIC which provides high immunity to false triggering from RFI (hand-held radios) and EMI (electrical noise on the line), superior performance, and greater reliability.

J. Passive infrared sensors shall have a multiple segmented Fresnel lens, in a multiple-tier configuration, with grooves-in to eliminate dust and residue build-up.

K. Where specified, passive infrared and dual technology sensors shall offer daylighting footcandle adjustment control and be able to accommodate dual level lighting.

L. Dual technology sensors shall be corner mounted to avoid detection outside the controlled area when doors are left open.

M. Dual technology sensors shall consist of passive infrared and ultrasonic technologies for occupancy detection. Products that react to noise or ambient sound shall not be considered.

N. Ultrasonic sensors shall utilize Advanced Signal Processing to adjust the detection threshold dynamically to compensate for constantly changing levels of activity and air flow throughout controlled space.

O. Ultrasonic operating frequency shall be crystal controlled at 25 kHz within + 0.005% tolerance, 32 kHz within + 0.002% tolerance, or 40 kHz + 0.002% tolerance to assure reliable performance and eliminate sensor crosstalk. Sensors using multiple frequencies are not acceptable.

P. All sensors shall be capable of operating normally with electronic ballasts, PL lamp systems and rated motor loads.

Q. Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to the cycling of air conditioner or heating fans.

R. All sensors shall have readily accessible, user adjustable settings for time delay and sensitivity. Setting shall be located on the sensor (not the control unit) and shall be recessed to limit tampering.

S. In the event of failure, a bypass manual override shall be provided on each sensor. When bypass is utilized, lighting shall remain on constantly or control shall divert to a wall switch until sensor is replaced. This control shall be recessed to prevent tampering.

T. All sensors shall provide an LED as a visual means of indication at all times to verify that motion is being detected during both testing and normal operation.

U. Where specified, sensor shall have an internal additional isolated relay with Normally Open, Normally Closed and Common outputs for use with HVAC control, Data Logging and other control options. Sensors utilizing separate components or specially modified units to achieve this function are not acceptable.

V. All sensors shall have UL rated, 94V-0 plastic enclosures.

W. Outdoor motion sensors shall have UL 773A ratings. EWF outdoor sensors shall additionally have UL 1571 ratings.

X. EW-100 outdoor sensors shall cover up to 35 feet, with a field of view of 180 degrees. EW-200 outdoor sensors shall cover up to 52.5 feet, with a field of view of 270 degrees. EN-100 outdoor sensors shall cover up to 35 feet, with a field of view of 90 degrees. EN-200 outdoor sensors shall cover up to 100 feet, with a long range lens view.

Y. EWF outdoor sensors shall include polycarbonate lamp holders that accept PAR 20 or 38 lamps up to 150W per lamp.

Z. Outdoor sensors shall have an operating temperature range of -40 degrees F to +130 degrees F.

AA. To ensure complete protection from weather elements and exposure, outdoor sensors shall be manufactured with precision double-shot tooling and contain internal silicon gaskets.

2.2 CIRCUIT CONTROL HARDWARE – CU

A. Control Units: For ease of mounting, installation and future service, control unit(s) shall be able to externally mount through a 1/2" knock-out on a standard electrical enclosure and be an integrated, self-contained unit consisting internally of an isolated load switching control relay and a transformer to provide low-voltage power. Control unit shall provide power to minimum of two (2) sensors.

B. Relay Contacts shall have rating of:

13A - 120 VAC Tungsten
20A - 120 VAC Ballast
20A - 277 VAC Ballast

C. Control wiring between sensors and controls units shall be Class II, 18-24 AWG, stranded UL Classified, PVC insulated or TEFLON jacketed cable suitable for use in plenums, where applicable.

D. Minimum acceptable wire gauge from the circuit control hardware relays shall be #14 AWG.

PART 3 - EXECUTION

3.1 INSTALLATION

A. It shall be the Contractor’s responsibility to locate and aim sensory in the correct location required for complete and proper volumetric coverage within the range of coverage(s) of controlled areas per the manufacturer’s recommendations. Rooms shall have 90 to 100% coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the room(s). The locations and quantities of sensors shown on the drawings are diagrammatic

and indicate only the rooms which are to be provided with sensors. The Contractor shall provide additional sensors if required to properly and completely cover the respective room.

B. 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.

C. 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. The Contractor shall also provide, at the Owner's facility, the training necessary to familiarize the Owner's personnel with the operation, use, adjustment, and problem solving diagnosis of the occupancy sensing devices and systems.

3.2 FACTORY COMMISSIONING

A. Upon completion of the installation, the system 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.

B. The electrical contractor shall provide both the manufacturer and the Electrical Engineer with ten (10) working days written notice of the scheduled commissioning date. Upon completion of the system fine tuning the factory authorized technician shall provide training to the Owner's personnel in the adjustment and maintenance of the sensors.

END OF SECTION

SECTION 26 22 00

DRY TYPE TRANSFORMERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The work required under this section of the Specifications consists of the furnishing, connection and installation of dry type transformers.

1.2 QUALITY ASSURANCE

A. The requirements of the following standards shall become a part of this Specification by reference:

1. Underwriters Laboratories Inc. (UL) Publications:
   No. 506, 1561: Transformers (1,000 kVA, 3-phase and below; 167 kVA, 1 phase and below)
2. National Fire Protection Association (NFPA):
   No. 70: National Electrical Code (NEC)
3. National Electrical Manufacturers Association (NEMA):
   No. St-20: Dry-type transformers for general applications
4. American National Standards Institute (ANSI/IEEE) C57.12.91 Standard Test Code for Dry-Type Distribution and Power transformers.
5. U.S Department of Energy 10 CFR Part 431 Energy Conservation Program: Energy Conservation Standards for Transformers: Final Rule, dated April 18, 2013. These efficiency standards shall take effect January 1, 2016. Transformers covered in the scope of this document and this specification, manufactured after December 31, 2015, shall be compliant with this standard.

B. Manufacturer Seismic Qualification: The low voltage general purpose dry type transformers (1000kVA max.) shall meet and be certified to seismic requirements specified in the IBC 2009 International Building Code.

1. Low voltage general purpose dry type transformers shall be compliant with the IBC parameters.
   a. lp-Importance Factor: 1.5-Components must function after an earthquake for life safety purposes (Building Occupancy Code IV)
   b. Sds-For ventilated transformers Sds is <=2.00g as standard up to 1000 kVA. Encapsulated transformers Sds is 2.00g
   c. z/h-Height factor ratio: 1.00 *Note:* ratio is a calculated value equal to the floor the gear is installed on divided by 12 (A 6th floor installation is a 0.5n value and a basement or ground floor installation is a 0.0 value)

C. Acceptable Manufacturers

1. General Electric
2. Square D
3. Siemens
4. Eaton

D. Coordination: Coordinate installation with architectural and structural features, equipment installed under other sections of the Specifications to ensure transformer access, clearance minimums, and adequate ventilation are provided.

PART 2 - PRODUCTS

2.1 GENERAL MATERIALS REQUIREMENT

A. Furnish all materials specified herein and indicated on the drawings.

B. All transformers shall be UL Listed and bear a UL Label.

2.2 GENERAL PURPOSE DRY TYPE TRANSFORMERS

A. Insulation System

1. Single-phase 25-167 kVA and 3-phase 30-500 kVA: Transformers shall be rated for average temperature rise by resistance of 150 degrees C in 40 degrees C maximum ambient, 30 degrees C average ambient. Transformer insulation system shall be UL rated as 220 degrees C system.
2. 3-phase 3-15 kVA: Transformers shall be rated for average temperature rise by resistance of 115 degrees C. Insulation system shall be 180 degrees C.
3. All transformers shall have insulation systems of Class 155 or higher.

B. Sound rating shall comply with NEMA and ANSI standards for kVA rating. Internal vibration dampening shall be provided for all transformers.

C. Single-phase transformers rated up to 15 kVA shall have two (2) 5% full capacity taps below normal rated primary voltage. All other single-phase and all 3-phase transformers shall be provided with six (6) 2-1/2% full capacity taps, two (2) above and four (4) below normal voltage, unless only four (4) 2-1/2% taps, two (2) above and two (2) below normal voltage are standard.

D. Construction/Enclosures

1. Transformers 30-1,500 kVA: Transformer enclosures shall be ventilated and drip-proof with removable front and rear cover panels. Transformers shall be suitable for floor mounting unless wall mounting is indicated on the drawings.
2. Transformers up through 25 kVA: Transformer housings shall be totally enclosed, non-ventilated and drip-proof. Access to wiring compartment shall be permitted via removable panel.

E. Core assemblies and the center ground point of the coil secondaries shall be grounded to the enclosure by flexible ground straps. Provide grounding lug at the enclosure bonding location for connection of three conductors: the primary and secondary equipment grounding conductors and the grounding electrode conductor.

F. Transformer coils shall consist of aluminum windings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall provide not less than twelve inch clearance from combustible materials and not less than 6" clearance from walls or equipment. Floor-mounted transformers shall be mounted on neoprene, waffle type vibration pads 5/8" thick. Where transformers are mounted on channels angles, transformers shall be bolted to structure with 5/8" thick vibration pad between transformer base and structural channel. 4" thick concrete housekeeping pads shall be used for all floor-mounted transformers.

B. Provide working clearance and full accessibility for transformer as required by the National Electrical Code.

C. Primary and secondary connections to dry type transformers shall be made with flexible conduit.

D. The secondary windings of each dry type transformer shall be grounded in accordance with the National Electrical Code requirements for separately derived electrical systems. Extend a grounding electrode conductor from the transformer grounding lug to the nearest building structural steel and to the nearest available point on the interior water piping system. Connect the primary and secondary feeder, equipment grounding conductors to the grounding lug, also. Refer to the grounding section of these Specifications for additional requirements.

3.2 CLEANING AND ADJUSTMENT

A. Prior to job completion, clean the interior and exterior of dirt, paint and construction debris.

B. Touch-up paint scratched surfaces with factory furnished touch-up paint of the same color as the factory applied paint.

END OF SECTION

SECTION 26 24 13

SWITCHBOARDS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The work required under this section of the Specifications consists of the installation of all switchboards for use on systems 600 volts and below. All materials and devices which are an integral part of the switchboards shall be provided under this section of the Specifications.

B. Switchboards as specified in these Contract Documents are free standing, dead-front, metal enclosed panels of one or more sections. The overcurrent devices may be individually or group mounted.

1.2 QUALITY ASSURANCE

A. Acceptable Manufacturers: Products of the following manufacturers, which comply with these Specifications, are acceptable:

1. Square D
2. Siemens
3. Cutler Hammer
4. ABB-GE

B. Equipment Dimensions

1. Dimensions noted on the Drawings are the maximum allowable and shall not be exceeded. Where switchboard(s) of acceptable manufacturers listed exceed the maximum dimensions, products of such manufacturers shall not be acceptable.

C. Coordination

1. Coordinate installation with architectural and structural features, equipment installed under other sections of the Specifications and electrical equipment to ensure access and so that clearance minimums are provided.

1.3 SUBMITTALS

A. Refer to Section 26 00 00 - Electrical General for submittal requirements.

B. Shop Drawings: Submit shop drawings to indicate compliance with the Contract Documents.

1. Include electrical characteristics and ratings for each switchboard with dimensions, mounting, bus material, voltage, bracing, ampere rating, mains, poles and wire connection, and any accessories.
2. Include bussing diagram indicating each circuit breaker or fused switch position.
3. Provide a schedule indicating overcurrent device, trip and size, poles, frame type, fuse size and type, or circuit breaker interrupting capacity.

1.4 SHORT CIRCUIT AND PROTECTIVE DEVICE STUDY

A. Contractor shall provide a Short Circuit and Protective Device Study to verify the proposed equipment ratings and protective device ratings. The study shall be performed by a licensed professional engineer or other qualified persons engaged primarily in the design, installation, or maintenance of electrical systems.

B. The scope of the study shall include all proposed distribution equipment supplied under this contract.

C. Contractor shall obtain, in writing, the short circuit current value at the main service switchboard for the specific project location from the utility.

D. All service equipment shall be legibly marked in the field with the maximum available fault current and the date the fault current calculation was performed in accordance with NEC 110.24.

E. A copy of the Short Circuit and Protective Device Study shall be included in the shop drawing submittals for the equipment, and made available to those authorized to design, install, inspect, maintain, or operate the system.

1.5 PROTECTIVE DEVICE COORDINATION STUDY

A. Contractor shall provide a protective device coordination study for:

1. Distribution systems required to be selectively coordinated that contain circuit breakers.
2. Distribution systems containing breakers with adjustable trip settings.
3. Distribution systems requiring arc-flash analysis.

B. The study shall be performed by a licensed professional engineer or other qualified persons engaged primarily in the design, installation, or maintenance of electrical systems.

C. A copy of the Protective Device Coordination Study shall be included in the shop drawing submittals for the equipment, and made available to those authorized to design, install, inspect, maintain, or operate the system.

1.6 ARC FLASH LABELING

A. Arc flash labels shall be factory provided and installed in accordance with NFPA 70.

B. A permanent label shall be factory applied to service equipment rated 1200 amps or more. The label shall meet the requirements of NFPA 70 and contain the following information:

1. Nominal system voltage
2. Available fault current at the service overcurrent protective devices
3. The clearing time of service overcurrent protective devices based on the available fault current at the service equipment
4. The date the label was applied

PART 2 - PRODUCTS

2.1 GENERAL

A. Furnish all materials specified herein.

B. The switchboard, circuit breakers, and fused devices shall be UL Listed and bear the UL Label. Where a switchboard is utilized as service entrance equipment, it shall be UL Labeled as suitable for such use.

C. The switchboard(s) shall be suitable for operation on the voltage system indicated on the Drawings.

2.2 STRUCTURE ARRANGEMENT

A. The switchboard(s) shall consist of free-standing, standardized vertical sections bolted together to form a continuous structure.

B. Adequate space for conduit and conductors entering the top or bottom, in accordance with the National Electrical Code, shall be provided without structural interference, conductors shall be safely accessible without disrupting service.

C. The structure and all components shall be finished in the manufacturer's standard corrosive-resistant primer and coating.

D. Unless noted otherwise, switchboard sections shall be front accessible.

2.3 BUS ARRANGEMENT

A. All busses shall be tin-plated aluminum, rated for a 65 degrees C temperature rise above a 40 degrees C ambient. The minimum bus bracing, in RMS-symmetrical-amperes, shall be as shown on the Drawings.

B. A neutral bus bar shall be provided, rated 100% of the main phase bus bar ampacity.

C. The main bus shall be fully rated for the entire length of the switchboard.

D. All non-current-carrying parts of the switchboard shall be grounded through the use of a continuous horizontal ground bus connected to vertical ground busses in each section. Ground bus rating shall meet or exceed the ampacity of the electrical service grounding electrode conductor(s).

E. An accessible cable termination compartment shall be provided for incoming line termination for main lug only applications. Lugs shall be suitable for terminating the size and quantity of conductors as indicated.

F. All terminal lugs shall be UL Labeled for AL or CU conductors rated for 75 degrees C.

2.4 MAIN PROTECTIVE DEVICE(S)

A. The main protective device(s) shall employ fixed type mounting. The devices shall be individually mounted in the switchboard.

B. Provide molded case circuit breaker(s)

1. Breaker(s) shall be 600V AC, 50/60 HZ rated. The frame and current ratings shall be as indicated on the Drawings.
2. Circuit breaker(s) shall be of the quick-make, quick-break, trip-free solid state type. Solid state breaker trip functions shall include adjustments for continuous amperage, long time pickup and delay, instantaneous, and ground-fault pickup and delay.

C. Provide insulated case circuit breaker(s)

1. Breaker(s) shall be 600V AC, 50/60 HZ rated. The frame and current ratings shall be as indicated on the Drawings.
2. Circuit breaker trip functions shall include adjustments for continuous amperage, long time pickup and delay, instantaneous, and ground-fault pickup and delay. Fault indication shall be provided on the trip unit for overload, short time, short circuit, and ground fault conditions.

3. Breaker(s) must carry a UL 429 Listing, be rated for 100% continuous duty, approved for reverse connection, and shall be stationary mounted, suitable for manual operation. Breaker(s) must carry an individual serial number with factory-maintained production and test records.
4. The breaker operating mechanism shall be a true two-step stored energy mechanism that shall provide a five cycle maximum closing time. Separate indicators shall be provided to show charged/discharged status of the mechanism and open/closed status of the breaker's contacts. The breaker mechanism shall enable to be discharged without closing the main contacts. The manual charging handle shall be interlocked with the manual close button to prevent simultaneous operation.

D. Provide fused switch(es)

1. Switch(es) shall be 600V AC, 50/60 HZ rated and shall be UL Listed for application at 100% of their continuous current rating. The current rating shall be as indicated on the Drawings.
2. Switch(es) shall be bolted pressure contact, load interrupting, fast-acting stored energy type, fused devices. The contact interrupting capacity shall be 12 times the continuous current rating and 200,000 AIC for the combination of switch and fuse. The switch shall have electrical trip mechanism.
3. Fast-acting current limiting fuses shall be installed in each ungrounded leg of the switch.
4. Switch shall be equipped with "blown fuse" protection to automatically trip switch upon loss of any fuse.
5. Switch shall be equipped with factory installed ground fault sensing system and indication.

E. Provide phase-loss protection

1. Phase loss protection system shall trip the main disconnect device(s) under single-phase condition or a voltage imbalance of 12% or more.
2. The system shall not trip on total loss of voltage on all phases and shall have a built-in time delay with a range of 3 - 12 seconds. Capacitor trip component is required.
3. The system shall be equipped with LED fault indicators installed on the front of switchboard enclosure.

2.5 DISTRIBUTION PROTECTIVE DEVICES

A. Provide molded case circuit breakers

1. Circuit breakers shall be provided with trip rating, poles and minimum interrupting rating as indicated on the Drawings or specified herein.
2. Circuit breakers 600 amps or less shall be of the quick-make, quick-break, trip-free thermal magnetic type.
3. Circuit breakers greater than 600 amps shall be of the quick-make, quick-break, trip-free, solid state type. Solid state breaker trip functions shall include adjustments for continuous amperage, long time pickup and delay, instantaneous, and ground-fault pickup and delay.
4. Circuit breakers shall be bolted to the switchboard bus.
5. Provide shunt trip device to electrically trip circuit breakers where indicated on the Drawings.

2.6 AUXILIARY EQUIPMENT

A. Identification

1. Refer to Section 26 00 00 - Electrical General for nameplate requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install switchboard on 4" high concrete pad, the horizontal dimensions of which shall exceed the base dimensions of the switchboard by 3" on all sides.

B. Lace and group conductors installed with nylon tie straps. Only one conductor shall be installed under each terminal. Form and train conductors in enclosure neatly parallel and at right angles to sides of box. Un-insulated conductor shall not extend beyond 1/8" from terminal lug.

C. Do not splice conductors in switchboard. Where required, install junction box adjacent to enclosure and splice or tap conductors in box. Refer to number of conductors in a conduit limitation defined in the conductors and cables section of the Specifications and do not exceed.

D. Maintain conductor phase color code requirement described in the conductors and cables section of the Specifications.

E. Switchboard name/designation shall be labeled per the requirements of Section 26 00 00 - Electrical General 2.02 A, as well as each individual feeder breaker/fused switch and branch circuit breaker/fused switch.

F. Any circuit breaker provided with arc energy reducing maintenance switch shall be labeled “BREAKER IS PROVIDED WITH ARC ENERGY REDUCING MAINTENANCE SWITCH”. Labeling shall be per the requirements of Section 26 00 00 – Electrical General 2.02A.

3.2 CLEANING AND ADJUSTMENT

A. After completion, clean the interior and exterior of dirt, paint and construction debris.

B. Circuit breaker adjustments shall be performed as directed by the Engineer at projection completion.

END OF SECTION

SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. All work specified herein shall be accomplished in accordance with the applicable requirements of Section 26 00 00 - Electrical General.

B. Provide the panelboards indicated on the Drawings complete with overcurrent protection devices and spaces.

C. This section includes panelboards and distribution panelboards and associated auxiliary equipment rated 600 V or less as shown on the drawings.

D. Refer to panel schedule and one-line power diagram on drawings for specific requirements of each panel.

1.2 WORK INCLUDED

A. The work under this section shall include all labor, materials, accessories, services and equipment necessary to furnish and install panelboards, complete, as indicated on the Drawings and as specified herein.

B. Equipment schedules and specifications are based on the one manufacturer listed in the schedule. Other manufacturers of equal quality and performance may be submitted to the Engineer for review. When substitution of equipment is made, the Contractor shall be responsible for the costs of any item and engineering and construction revisions necessary in his or any other contract or trade that may be required to satisfy plans and specifications.

1.3 QUALITY ASSURANCE

A. Panels shall be factory assembled.

B. Coordination: Coordinate installation with architectural and structural features, equipment installed under other sections of the Specifications and electrical equipment to ensure panel access and so that clearance minimums are provided.

C. Components and installation shall be in accordance with NFPA 70, “National Electrical Code,” NEMA PBI, “Panelboards” and UL67 and UL50.

D. Panelboards and load centers shall be listed and identified for use with 75 degrees C rated conductors.

1.4 SUBMITTALS

A. Refer to Section 26 00 00 - Electrical General for submittal requirements.

B. Manufacturers Product Data:

1. Submit material Specifications and installation data for products specified under Part 2 - Products to include:
   a. Overcurrent protection devices
   b. Panelboards

C. Shop Drawings: Submit shop drawings to indicate information not fully described by the product data to indicate compliance with the Contract Drawings.

1. Include electrical characteristics and ratings for each panelboard with dimensions, mounting, bus material, voltage, ampere rating, mains, poles and wire connection, and any accessories. Indicate method of ground bus attachment to enclosure.
2. Include bussing diagram indicating each bussing overcurrent protection device position.
3. Provide a schedule indicating overcurrent protection device type, trip and size, poles, frame type, interrupting capacity.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Panelboard manufacturer shall be:

1. Siemens
2. Square D
3. ABB-GE
4. Cutler-Hammer

2.2 GENERAL REQUIREMENTS

A. All panels and overcurrent protection devices shall be UL Listed and bear a UL Label. Where panel serves as service entrance equipment, panel shall bear a UL Label indicating suitability as service entrance equipment.

B. Panels shall be of the dead front safety type.

C. Provide panels complete with factory assembled circuit breakers or fuses connected to the bus bars in the positions shown on the panel schedules.

D. Provide all panelboards fully rated to the A.I.C. ratings noted on the schedules, but not less than 10,000 amperes for 120/208 volt panelboards and not less than 14,000 amperes for 277/480 volt panelboards. All devices in a panelboard shall be rated for the A.I.C. ratings shown for the panelboard.

2.3 BUSSING AND INTERIORS

A. All bus bars shall be aluminum. Main lugs and main overcurrent protection devices shall be UL approved for copper or aluminum conductors and shall be of a size range for the conductors indicated on the drawings. Each panel shall contain a full size grounding bus. All panelboards shall contain a full size insulated neutral bus unless otherwise indicated on the drawings.

B. The neutral and ground bus shall have a sufficient number of lugs to singularly terminate each individual conductor requiring a connection.

C. Where designated on panel schedule as “space,” include all necessary bussing, device support and connections. Provide blank cover for each space.

D. Where specified or indicated on the drawings, provide sub-feed lugs adjacent to the mains or feed-through lugs opposite end of mains and increase box heights to provide additional cable bending and termination space. Lugs to be the same size and capacity as mains and rated for aluminum or copper conductor terminations.

2.4 ENCLOSURES

A. Panelboard width shall not be less than twenty inches unless indicated on the drawings (32" minimum for distribution panelboards).

B. Provide concealed captive clamping devices, concealed hinges and chrome lock for all flush mounted panels. Key all panels throughout project alike.

C. Where two section panels are required, both sections shall have fully rated bus, separate cabinets connected by conduit nipples. Interconnect sections with copper conductors with ampacity equal to rating of main bus. Route phase and neutral conductors together between panels. Provide separate trims for each section.

D. Provide a label for each branch circuit, feeder, and main circuit breaker in distribution panels, permanently attached per the requirements of Section 26 00 00 - Electrical General, 2.02A.

E. Cabinets, flush or surface mounted as indicated. NEMA PB-1, Type 1 enclosure, except where the following enclosure requirements are indicated:

1. NEMA 250, Type 3R - Raintight.
2. NEMA 250, Type 3S - Raintight and dust tight.
3. NEMA 250, Type 4X - Corrosion-resistant stainless steel enclosure, watertight, dust tight, and resistant to oil and coolant seepage. This type shall be used in kitchen areas.
4. NEMA 250, Type 12 - Dust tight, drip proof, and resistant to oil and coolant seepage.

F. Enclosure shall be fabricated with galvanized steel. Trims shall have electrostatic applied ANSI gray enamel finish and adjustable indicating trim clamps for securing trim to the enclosure. Screwed-on trims shall not be acceptable. Trim shall have an angle support along the bottom serving as a support between trim and enclosure for safe installation and removal of trim.

G. Exterior Panels: Panelboards mounted outside of building shall be in NEMA type 3R enclosures. Panelboards shall have in addition to the standard specified items the following:

1. Piano hinge
2. Seams continuously welded
3. Rolled lip around door and cabinet
4. No knockouts or holes
5. Neoprene gaskets on inside of door
6. Stainless steel hardware
7. Drip hood at top above door

2.5 CIRCUIT BREAKERS

A. Interrupting rating of all circuit breakers in panelboards shall have UL rating of not less than the RMS symmetrical amps indicated on the Drawings at system voltage. Series rated devices are acceptable with the following exceptions: devices used in distribution serving emergency, standby and multiple elevator loads (selective coordination).

B. Circuit breakers shall be provided with trip rating and poles as indicated on the drawings or specified herein.

C. Multi-pole breakers shall be common trip and common reset; tie handle connection between single pole breakers is not acceptable.

D. Branch circuit breakers in lighting and appliance panels shall be quick-make, quick-break, thermal magnetic type bolted to the bus. Circuit breakers in distribution type panelboards shall be bolted to the bus.

E. Provide the following special devices and accessories when indicated on the drawings or specified herein.

1. Ground fault interrupting circuit breakers (GFI) where indicated on the drawings.
2. Provide handle lock-on device (to prevent manually turning off device without removal) for all overcurrent devices where indicated on panelboard schedules, and for those protecting circuits serving fire alarm equipment, and for those dedicated for powering emergency battery-powered unit equipment.
3. Provide UL Listed “SWD” switching duty circuit breakers on the devices indicated on the drawings.
4. Provide shunt trip device for electrically tripping circuit breakers indicated on the drawings.
5. Overcurrent protective devices for fire alarm circuits shall have handles that are factory-marked in the color red.

2.6 LOAD CENTERS

A. Individual apartment unit panels shall be “Load Center” type of amperage indicated on drawings.

B. Branch breakers shall be plug-in type.

C. Arc-fault circuit breakers shall protect 15- and 20-amp branch circuits in dwelling units serving lighting, receptacles and smoke detectors except for those located in bathrooms, garages and outdoors.

D. Load center trims shall be factory-painted white if directed by owner.

2.7 FUSIBLE COORDINATION PANELBOARDS

A. Interrupting rating of all fuses in panelboards shall have UL rating of not less than the RMS symmetrical amps indicated on the Drawings at system voltage.

B. Fusible panelboards shall be listed to UL 67.

C. Furnish 10% or minimum of three fuses of each rating and type of fuse installed, in addition to any spares indicated in schedule.

D. Panelboard overcurrent device interrupting ratings shall be fully rated for the maximum available fault current and have a U.L. listed interrupting rating of 300kA and CSA certified interrupting rating of 200kA.

E. Panelboard circuits 100A and less shall incorporate overcurrent protection and branch-circuit disconnecting means into a single integrated component.

F. Interiors shall be factory assembled.

G. Panelboard shall be equipped with a six-space spare fuse compartment for storing replacement branch circuit fuses.

H. Bus bars shall be tin-plated copper.

I. Neutrals shall be fully rated.

J. Where equipped with main disconnect, permanently installed lockout means shall be provided on the disconnect for lockout tag procedures.

K. Main disconnect shall be quick-make, quick-break type.

L. Main and Branch Overcurrent Protection

1. All overcurrent protective devices shall have a minimum U.L. listed interrupting rating of 300kA and CSA Certified interrupting rating of 200kA.
2. Main overcurrent protective devices shall be 600Vac UL Listed minimum 300kA IR and CSA Certified minimum 200kA IR Class J time-delay fuses or Class J performance fuses.
3. Branch circuit overcurrent protection shall be 600Vac UL Listed minimum 300kA IR and CSA Certified minimum 200kA IR finger-safe fuse with Class J performance fuses.
4. Where panelboard main fuses are installed, fuses in panelboard branch circuits shall selectively coordinate with main fuses for all overcurrents up to 200kA.

M. Branch fused disconnects

1. Device shall have visible ON/OFF indication with colored and international symbol markings.
2. Device shall provide open fuse indication permanently installed neon indicating light.
3. Device shall be UL and cUL Listed 600Vac/200kA or 125Vdc/100kA voltage/short-circuit current rating, load-break disconnect with amp ratings and number of poles as indicated on the panelboard schedule.
4. Fuse and disconnect assembly shall be a finger-safe component with trim installed.
5. Fuse and disconnect shall be interlocked to disallow fuse removal while fuse terminals are energized.
6. No special tools shall be required for fuse removal.
7. Devices shall have bolt-on style bus connectors.
8. Device housing shall be clearly marked with device amperage.
9. Device shall provide fuse amp rating rejection at the following ampacities to ensure continued circuit protection at the specified circuit rating: 15A, 20A, 30A, 40A, 50A, 60A, 70A, 90A and 100A.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide from each flush mounted panelboard four (4) 3/4" empty conduits stubbed out above ceiling line and capped (not applicable to living unit load centers).

B. Install panelboards in accordance with NEMA PB1.1, “General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less” and manufacturer’s written installation instructions.

C. Mount panelboards with top circuit breaker not more than 6'-6" above finished floor.

D. Only one conductor installed under terminal of individual circuit breakers. Form and train conductors in panel enclosure neatly parallel and at right angles to sides of box. Un-insulated conductor shall not extend beyond one-eighth inch from terminal lug.

E. Do not splice conductors in panels. Where required, install junction box adjacent to panel and splice or tap conductors in box.

F. Mounting and Support

1. Mounting
   a. Enclosure shall be secured to structure by a minimum of four (4) fastening devices. Panelboards 600 amp and larger shall be secured by a minimum of eight (8) devices. A 1.5 inch minimum diameter round washer shall be used between head of screw or bolt and enclosure.
   b. Enclosures shall be mounted where indicated on the drawings or specified herein. Support from the structure with fastening device specified.
   c. Attach enclosure directly to masonry, concrete, or wood surfaces.
   d. Mounted enclosure on metal channel (strut), which is connected to structure with fastening device specified, for installation on steel structure or sheet rock walls.

G. Maintain conductor phase color code requirements described in the conductors and cables section of the specifications.

H. A typewritten branch circuit directory (based on as-built conditions) shall be provided for each panelboard and load center, permanently mounted on inside of door in a transparent, protective cover. Room number(s) or room name(s) shall be included in the circuit description in coordination with the final naming/numbering scheme for the project (e.g. “Office Receptacles” shall read “Office Receptacles – Rm. 202, 203”).

I. Any circuit breaker provided with arc energy reducing maintenance switch shall be labeled “BREAKER IS PROVIDED WITH ARC ENERGY REDUCING MAINTENANCE SWITCH”. Labeling shall be per the requirements of Section 26 00 00 – Electrical General 2.02A.

J. Install panelboard ground fault circuit interrupter devices in accordance with installation guidelines of NEMA 289, “Application Guide for Ground Fault Circuit Interrupters.”

K. Tighten electrical connectors and terminals, including grounding connections, in accordance with manufacturer’s published torque-tightening values. Where manufacturer’s torque values are not indicated, use those specified in UL 486A and UL 486B.

L. Mounting of all panelboards and all hardware used for mounting shall be in accordance with the seismic criteria per the applicable building code.

M. Fusible coordination panelboards shall be shipped without branch circuit fuses installed. Branch circuit fuses shall be shipped separately with the chassis. Where main fuses are specified 100A or greater, equipment shall be shipped with main fuses installed.

END OF SECTION

SECTION 26 26 53

ELECTRIC VEHICLE CHARGING EQUIPMENT

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

A. General Conditions: Refer to the General Conditions, the Supplementary General Conditions and the Special Conditions, all provisions of which apply to work under this section as if written in full herein.

B. The scope of work to be done under this section of the specifications shall include the furnishing of labor, material, equipment and tools required for the complete installation of EV charging equipment that provides Level 2 EV charging. Furnish and install all Electric Vehicle Charging Systems as specified herein and as indicated on the drawings.

C. The drawings and specifications are complementary to each other and what is called for by one shall be as binding as if called for by both.

1.2 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

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

C. Comply with UL 2231-1. UL 2231-2, UL 2594, and NEC Article 625.

D. Comply with SAE J1772.

E. Comply with FCC Part 15 Class A.

1.3 SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for EV charging equipment.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For EV charging equipment.

1. Include plans, elevations, sections, and mounting/attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of mounting assemblies for EV charging equipment.
4. Include diagrams for power, signal, and control wiring.
5. Include verification of wireless communications service at each location of EV charging equipment.

1.4 WARRANTY

A. Comply with the requirements of the General Conditions and Section 26 00 00.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Electric Acceptable Manufacturers: Products of the following manufacturers, which comply with these Specifications, are acceptable:

1. ChargePoint
2. Schneider Electric
3. Leviton
4. Approved equal.

2.2 EV CHARGING EQUIPMENT DESCRIPTION

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

B. Comply with NFPA 70.

C. ADA compliant.

D. Metering: +/- 2 percent from 2 percent to full scale of output (30 A).

E. EV Charging Equipment Mounting: Bollard or Wall mount.

F. Enclosures:

1. Rated for environmental conditions at installed location.
   a. Indoor Locations: NEMA 250, Type 3R.
   b. Outdoor Locations: NEMA 250, Type 3R.
   c. Aluminum and UV-resistant plastic.
   d. Paint and Anodized.
   e. Charging components protected by security screws.
   f. Charging connectors in locking holsters.
   g. Meter, modem, and CPU, tamper resistant.

G. EV Cable and Connectors:

1. SAE J1772 connector(s) with locking holster.
2. 18-foot (5.5 m) cable(s) with cable management system.

H. Status Indicators:

1. LEDs to indicate power, vehicle charging, charging complete, system status, faults, and service, as well as authorization.

I. Display Screen:

1. VGA-resolution, daylight-viewable LCD screen with UV protection. Daylight readable and fingerprint resistant.
2. Displays power, charging, charging complete, remote control, system status, faults, payment and pricing details, and service.

J. Networking:

1. WAN Communications: Cellular GSM/GPRS and CDMA.
2. LAN Communications: 2.4 GHz Wi-Fi 802.11b/g/n.
3. Capable of remote configuration, diagnostics and reporting.
4. Capable of remote software updates (future proof).

K. Payment System:

1. RFID (ISO 15693, ISO 14443), NFC, Contactless credit card reader.
2. PCI (Payment Card Industry) compliant.
3. Capable of remote control and authorization including mobile phone application or toll-free phone number.

L. Charging Network:

1. Multiple units shall independently connect to charging network.
2. Multiple units shall have one unit designated as a master unit that is configured as a gateway unit between the EV charging equipment and the charging network.
3. Individual units shall be capable of indicating station status and availability providing or connecting user to customer support and remote control.

2.3 PERFORMANCE REQUIREMENTS

A. Surge Withstand: 6 kV at 3000 A.

B. Integral GFCI.

C. Auto-GFCI fault retry.

D. EV Charging Levels:

1. Single vehicle: AC Level 2 at up to 7.2 kWper vehicle.
2. Dual vehicles, AC Level 2 at up to 7.2 kW per vehicle.
3. Multiple vehicles simultaneously charging at a site using Automatic Power Load Management may be charged up to 7.2 kW per vehicle.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for EV charging equipment electrical conduit to verify actual locations of conduit connections before equipment installation.

C. Examine walls, floors, and pavement for suitable conditions where EV charging equipment will be installed.

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

3.2 INSTALLATION

A. All installation work shall be performed by a qualified person who is familiar with the installation, construction and operation of the equipment and the hazards involved.

B. Install per manufacturer’s recommendations and contract documents.

C. Install units plumb, level and rigid without distortion.

D. The station shall be floor mounted using the plate/pole assembly, J-Bolts and associated parts per manufactures recommendations.

E. Installation of the Station and Network shall follow the procedure in the published literature.

3.3 CONNECTIONS

A. Connect wiring according to Section 26 05 19.

B. Comply with grounding requirements in Section 26 05 26.

C. Comply with requirements for installation of conduit in Section 26 05 33.

D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections with the assistance of a factory-authorized service representative.

C. Tests and Inspections:

1. For each unit of EV charging equipment, perform the following tests and inspections:
   a. Unit self-test.
   b. Operation test with load bank.
   c. Operation test with EV.
   d. Network communications test.

D. EV charging equipment will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

END OF SECTION

SECTION 26 27 14

TENANT SUBMETERING SYSTEM

PART 1 - GENERAL

1.1 SYSTEM DESCRIPTION

A. Furnish and install a complete Tenant Metering System (TMS) as detailed on the Drawings and as described in this specification. The system shall include remote devices for utility metering, communication interface hardware, inter-communication wiring, and software, etc. where specified.

B. The TMS shall utilize Ethernet as the high-speed backbone network that supports direct connection of computer workstation with the metering devices connected to the network.

C. Application software shall be provided as described in Article 2.05 of this specification.

D. Basis of design shall be POWERLOGIC brand as manufactured by Square D Company. E-mon shall be an approved alternate.

1.2 REFERENCES

A. All electric meters shall be UL and cUL Agency compliance, Listed per 7207. They shall also have +/- 1% overall system accuracy (including instrument transformer accuracy) from 2% to 100% of rated load. Accuracy is to meet or exceed ANSI C12.1.

B. The water meters shall conform to AWWA Standard C-708, and be NSF 61 Certified.

C. The gas meter shall be an indoor non-compensated meter four-chamber synthetic diaphragm style.

1.3 SUBMITTALS

A. Indicate electrical and mechanical characteristics and connection requirements. TMS components shall be installed by the power equipment manufacturer. The Drawings shall clearly identify the components with the internal connections, and all Contractor connections.

B. Provide catalog sheets and technical data sheets to indicate physical data and electrical performance, electrical characteristics, and connection requirements.

1.4 QUALITY

A. The TMS vendor shall be ISO 9000 registered to demonstrate quality compliance.

B. TMS components included within the power equipment lineups shall be factory-installed, wired and tested prior to shipment to the job site.

PART 2 - PRODUCTS

2.1 ELECTRIC CABINETS AND METERS

A. Electric Metering Cabinet

1. The metering cabinet shall be a minimum UL Type 1 Listed steel enclosure with factory-supplied knock-outs.
2. The cabinet shall be lockable and provide for the application of a security seal.

3. The cabinet shall include built-in circuit protection and disconnect switch for the metering equipment.
4. The enclosure shall have one set of incoming terminals for connecting the voltage metering leads.
5. Control power and voltage sensing power shall be separated for distribution to each meter from this main set of incoming terminals.
6. Control power transformers shall not be needed for any power systems up to and including 480 volts.
7. Standard wiring harnesses for control power and voltage sensing shall be used to internally connect each row of meters. The harness may daisy-chain the voltage connections from meter to meter on each row of meters. Finger safe terminals are to be used to terminate the meter end of the wiring harness.
8. The meters shall be connected with common daisy chain wiring for the communications leads. The communication wiring shall be a single loop with all meters connected to the circuit and each end terminated in a common location. Communication wiring shall be arranged in such a manner as to minimize interference from the power wiring.
9. The enclosure shall have shorting terminal blocks for connecting the current transformer leads from the field to the meters. Shorting terminal blocks will only be provided for the number of meters ordered with each enclosure. The locations for shorting terminal blocks shall be pre-drilled and labeled for ease of installation should meters be added to the enclosure after installation at the customer site. A factory-installed wiring harness shall be provided to connect the CT circuit from the shorting block to the meter. (Low voltage current transformers do not require shorting terminal blocks.)
10. The metering cabinet shall make provisions for adding meters in the field without cutting or splicing the voltage or communication wiring harnesses.
11. The metering cabinet shall have separate terminal blocks for incoming and outgoing communications circuit connections.
12. The metering cabinet shall have space sufficient for the addition of an Ethernet Gateway, wireless communications and power supply as required.

B. Electric Meters

1. The meter shall be UL and cUL Listed per 7207. The meter module shall be rated for an operating temperature range of 0 degrees C to 60 degrees C.
2. The meter shall be calibrated as a system and be accurate to +/- 1% from 2% to 100% of the rated current over a temperature range of 0-60 degrees C. No annual recalibration by users shall be required to maintain these accuracies.
3. The meter shall directly accept both single or three-phase voltage input up to and including 480 volts line to line.
4. The meter shall be capable of monitoring circuits up to 5,000 amps and shall be user configurable.
5. Each meter shall have as standard an RS-485 data port using Modbus (RTU) protocol to allow multipoint communication. The RS-485 communications shall provide communications links up to 10,000 feet in length.
6. The information and capabilities provided by the meter shall include the following. The values shall be read directly from the meter display without the need for multipliers.
   a. Real Energy (kWh)
   b. Real Power (kW)
   c. Real Power Demand (kWd) readings
   d. Reactive Power (kVAR)
   e. Power Factor
   f. Current, per phase
   g. Voltage, per phase

7. The meter shall be a Square D PowerLogic Power Meter 210.

2.2 WATER METERS

A. Water meter shall be provided for each tenant location on the incoming cold water supply.

B. The meter shall be positive displacement or water jet style meter, housed in bronze or polymer reinforced plastic.

C. The meter shall conform to AWWA Standard C-708, and be NSF 61 Certified.

D. The meters shall range from 5/8" to 2".

E. Registers shall be permanently sealed, dust and waterproof, with tamper-proof features and incorporating six-wheel odometer totalizer.

F. Registers shall be available in U.S. gallons, cubic feet, or cubic meters.

G. Registers shall have an output contact for field interface to TMS. The output contact shall correspond to 1 pulse per unit of register reading (U.S. gallon, cubic feet, or cubic meter). Contacts should be rated 30 vdc at minimum of 1 ma.

H. Wireless metering systems can be utilized vs. hard contact totalizer, but must be approved prior to installation. Must utilize 902-928MHz frequency band with spread spectrum frequency hopping radio technology.

I. TMS provider shall provide and certify the water metering system.

2.3 COMMUNICATIONS

A. Ethernet Gateway

1. The Ethernet Gateway shall feature one 10/100baseT Ethernet port and one 100baseFX optical fiber port as standard.
2. The Ethernet Gateway shall provide 16 MB of internal non-volatile memory storage to display real-time tenant metering data, and historical time/date stamped interval reading data (data logging of up to 10 parameters per metering device, and a minimum of 38 days of non-volatile data logging at 15-minute intervals).
3. The Ethernet Gateway shall feature one or two serial communication ports: minimum one RS-485 serial port, with optional second port configurable for either RS-232 or RS-485 (support for 2-wire or 4-wire).
4. The Ethernet Gateway shall provide high speed Ethernet support for up to 32 devices per daisy chain.
5. The Ethernet Gateway shall support the following protocols: Ethernet – MODBUS/TCP HTTP, FTP. Serial – MODBUS, JBUS.
6. The Ethernet Gateway shall be UL, CUL, CE, NOM and FCC Class A compliant.
7. The Ethernet Gateway shall utilize Modbus/TCP protocol as its high-speed backbone network protocol.
8. The Ethernet Gateway shall be compliant to industrial temperature. It shall withstand an operating temperature range of -30 degrees C to +80 degrees C.
9. The Ethernet Gateway shall provide trilingual user interface that includes English, French, and Spanish.

10. All Ethernet cabling shall be installed by a qualified data communications cable installer or the electrical contractor qualified to install data communications equipment. All communications cabling shall be Category 5e rated for 100baseT, or optical fiber rated for 100baseFX, and rated according to the environment in which it is installed.
11. Setup of the Ethernet Gateway shall be accomplished via the on-board Ethernet port and a web browser. It shall also be possible via the Ethernet port to upgrade the firmware of the Ethernet Gateway in the field to accommodate new system features.

B. Additional Network Media Options

1. Ethernet shall be used where shown on the project drawings. Ethernet Gateways shall be provided by the TMS vendor and installed by the Contractor where specified. Ethernet network connections shall be established using industry standard Ethernet protocols such as TCP/IP. All components shall work with existing Ethernet Gateway, Router, and Hub technology. Use of Ethernet shall be transparent to TMS software and monitoring devices.

2.4 TENANT METERING SOFTWARE

A. The tenant metering software shall operate using the Windows XP operating system.

B. The tenant metering software shall have a simple user interface for managing account and meter information for each tenant.

C. The tenant metering software shall allow selection of the billing period (start date/time and end date/time) for billing purposes.

D. The tenant metering software shall support “interval data” readings of electricity imported from a database. For example: kWHrs (energy) and kWD (demand) from each meter in the system – typically sampled at 15, 30, or 60-minute intervals.

E. Tenant Metering Software Database Compatibility

1. Shall support reading “interval data” directly from a Microsoft SQL database.
2. Shall utilize Microsoft SQL to execute the database queries to minimize query times.
3. Microsoft Access shall not be acceptable.

F. The tenant metering software shall support grouping and aggregation of meters to combine multiple meters into one aggregate total reading. For example: multiple meters belong to one tenant – tenant requests one statement each month instead of multiple statements.

G. The tenant metering software shall support the following user-configurable utility bill calculations:

1. Electrical energy charges
2. Demand charges
3. Power factor charges
4. Water consumption charges
5. Taxes
6. Customer charge
7. Delivery charges
8. Custom miscellaneous charges

H. The tenant metering software shall include a “coincident demand” cost allocation function.

1. Determine the peak demand date and time for the main meter (at the utility service entrance).
2. Query the "interval data" database to identify the demand reading at each sub meter co-incident (at the same date and time) as the main meter.
3. Allocate cost of the monthly peak demand charge from the utility bill to each tenant – calculated from the actual meter demand readings for each tenant that are co-incident with the overall facility peak demand time and date.

I. The tenant metering software shall identify missing data points from the system database. The tenant metering software will execute the program even if some data points are missing, and will interpolate the missing data points, when feasible.

J. The tenant metering software shall provide support for multiple utility rates within the same application software program. Utility rate configuration shall be simple point-and-click operations. The user shall be able to add additional utility rates to the system as required.

K. The tenant metering software shall be authored by the meter manufacturer.

1. Meter manufacturer must have the capability to customize the tenant metering software core software program for special billing requirements.
2. Meter manufacturer shall provide complete documentation to the user for program operations and configuration. Provide written manuals and extensive on-line help screens.
3. System manufacturer shall maintain a full-time technical support group.
   a. Free telephone tech support center
   b. Free tech support web site
   c. Optional priority support (remote troubleshooting via modem); add modem where required
4. System manufacturer shall maintain a full-time engineering services group.
   a. System integration capabilities
   b. Energy usage consulting capabilities
   c. Power quality consulting capabilities
5. System manufacturer shall maintain a full-time customer training group.

L. The tenant metering software shall include the following output options:

1. Report: Usage by Tenant – a printout showing each tenant's monthly charges – with each tenant printed on a separate page.
2. Report: Owner Report – a printout showing the total bill calculated for the facility, and each meter designated to the Property Owner.
3. Spreadsheet: Summary Report – Export the total bill and each tenant's monthly bill amount to a Microsoft Excel spreadsheet file for custom reporting or data export by the user.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All control power, CT, PT, RS485 and Ethernet data communications wire shall be field-installed by the Contractor.

B. All wiring required to connect equipment lineups shall be installed by the Contractor.

C. Contractor metering interconnection wiring requirements shall be clearly identified on the TMS network drawings, including standard product data sheets and typical wiring diagrams.

3.2 SYSTEM START-UP AND TRAINING

A. On-site start-up and training of the TMS shall be included in the project bid. TMS vendor to include one-half day of on-site, hands-on orientation training for Owner personnel with the fully commissioned TMS system.

B. Start-up shall include a complete working demonstration of the TMS.

C. Training shall include standard documentation and hands-on exercises for Owner's electrical operations personnel to become familiar with operation of the TMS.

D. The project bid shall include two (2) days start-up assistance to include one (1) trip as a minimum.

E. The power monitoring manufacturer shall provide a dedicated telephone technical help center for customers.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. All work specified herein shall be accomplished in accordance with the applicable requirements of Section 26 00 00 - Electrical General.

1.2 WORK INCLUDED

A. The work under this section shall include all labor, materials, accessories, services and equipment necessary to furnish and install wiring devices, complete, as indicated on the Drawings and as specified herein.

B. Equipment schedules and specifications are based on the one manufacturer listed in the schedule. Other manufacturers of equal quality and performance may be submitted to the Engineer for review. The following manufacturers are allowed:

1. Hubbell
2. Pass & Seymour
3. Eaton
4. Leviton
5. Thomas & Betts/Steel City
6. Walker/Wiremold

When substitution of equipment is made, the Contractor shall be responsible for the costs of any item and engineering and construction revisions necessary in his or any other contract or trade that may be required to satisfy plans and specifications.

C. This section includes receptacles, connectors, switches, dimmers, timeclocks and coverplates.

1.3 QUALITY ASSURANCE

A. Wiring devices shall comply with applicable sections of NEMA Standard WD-1, NFPA 70, Article 100.

B. All special purpose receptacles shall be NEMA standard configuration.

C. Comparative devices by acceptable manufacturers are equal.

PART 2 – PRODUCTS

2.1 WIRING DEVICE DESCRIPTION AND MANUFACTURER – COMMON AREAS

A. Single & Duplex Receptacles (20 Amp)

1. Single or duplex type receptacle as indicated. 125V/20/A/2P/3W/G rating - NEMA - 5-20R type.
2. Face color shall be coordinated with architect and interior designer.
3. Manufacturer
   a. Hubbell 5362 Series

B. GFCI Duplex Receptacles

1. Duplex, feed-thru type ground fault current interrupter receptacle with test/reset buttons. 125V/20A/2P/3W/G rating - NEMA 5-20R type conforming to UL #498, UL #943 Class A and NEMA #WD1-4.02.
2. Manufacturer
   a. Hubbell GFRST20 Series

C. Isolated Ground Single & Duplex Receptacles

1. Single or duplex type receptacles as indicated. 125V/20A/2P/3W/IG rating - NEMA 5-20R type ground internally isolated from receptacle frame and ground pigtail or terminal screw.
2. Manufacturer
   a. Hubbell IG5352 Series

D. Clock/Flat Screen Receptacles

1. Single type receptacle with a recessed outlet clock hanger type mounting coverplate. 125V/15A/2P/3W/G - NEMA 5-15R type.
2. Manufacturer
   a. Hubbell RR151CH Series

E. Maintained Contact Switches

1. Provide toggle operated switches SPST, DPST, 3-way or 4-way operation as indicated. 277V/20A rating, quiet type, maintained contact, and a green hexagonal ground screw or ground pigtail, and side wired.
2. Manufacturer
   a. Hubbell 1221 Series (Color to match receptacles).

F. Momentary Contact Switches

1. Provide toggle or key operated switches as indicated with single circuit, 3-position center-off operation. 277V/20A rating, quiet type, momentary contact, spring loaded switch, and green hexagonal ground screw or ground pigtail, back and side wired.
2. Manufacturer
   a. Hubbell HBL155* (Color to match receptacle).

G. Maintained Contact Slider Type Switch (For Multi-Ganging with Dimmers)

1. Slide-operated switch (to match dimmer), single pole, 3-way or 4-way operation as indicated, 120/277V, 20A rating.
2. Manufacturer
   a. Leviton Monet Series
   b. Lutron Nova T Series

H. Slider Type Wall Box Dimmers

1. Slide operated AC solid state type dimmer with positive ON/OFF switching, integral surge protection, voltage stabilized output, RFI filtered and maximum lighting level adjustment. 120V/60Hz, unless noted otherwise, with lettering and/or nameplate as indicated. Dimmers shall have lowest profile available (wattage permitting).
2. Manufacturer

	Load Type				
	Incandescent/ Halogen	Dimmable CFL/LED (screw base)	Magnetic low voltage	Electronic low voltage	0-10V Fluorescent/ LED
Lutron Nova T Series	NT-600-XX	NTCL-253P-XX	NTLV-600-XX	NTELV-600-XX	NTSTV-DV-XX
Leviton SureSlide Series	6673-10X	6672-1LX	6611-PX	6615-P0X	
Leviton Renoir Series					AWSMG-7DW

I. Pilot Light Toggle Switches

1. Single pole, 3-way or 4-way, as indicated, conforming to UL #20, NEMA #WDI-3.02 and F.S. #W-S-896E. 277V/20A rating, quiet type, maintained contact, and a green hexagonal ground screw or ground pigtail, back and side wired. Red colored toggle to glow when switch is on.
2. Manufacturer
   a. Hubbell HBL1221PL Series

J. Weather-Resistant Receptacles

1. All 15- and 20-amp receptacles installed in damp or wet locations shall be listed weather-resistant type.

K. Tamper-Resistant Receptacles

1. All 15- and 20-ampere, 125- and 250-volt nonlocking-type receptacles in the areas indicated below shall be listed tamper-resistant receptacles.
   a. Common areas of multifamily dwellings.
   b. Business offices, corridors, waiting rooms and the like in clinics, medical and dental offices and outpatient facilities
   c. Subset of assembly occupancies including places of waiting transportation, gymnasiums, skating rinks, and auditoriums

L. Controlled Duplex Receptacles (20 Amp)

1. Duplex type receptacle, 125V/20/A/2P/3W/G controlled by an automatic control device (or by an automatic energy management system) shall be permanently marked with the universal "power" symbol to differentiate them from non-controlled receptacles.
2. Face color shall be coordinated with architect and interior designer
3. Manufacturer
   a. Hubbell BR20C1 – Split Wired
   b. Hubbell BR20C2 – Both Outlets Controlled

2.2 WIRING DEVICE DESCRIPTION AND MANUFACTURER – DWELLING UNITS

A. Duplex Receptacles (15 Amp)

1. 125V/15A/2P/3W/G rating - NEMA 5-15 R type, duplex receptacle with green hexagonal ground screw, mounting frame with plaster ears, back and side wired.
2. Face color shall be coordinated with architect and interior designer.
3. Manufacturer
   a. Leviton T5820-* Series

b. Hubbell CR20*TR Series

B. GFCI Duplex Receptacles

1. Duplex, feed-thru type ground fault current interrupter receptacle with test/reset buttons. 125V/20A/2P/3W/G rating - NEMA 5-20R type conforming to UL #498, UL #943 Class A and NEMA #WD1-4.02.
2. Manufacturer
   a. Leviton T7899 or approved equal
   b. Hubbell GFRST20* Series

C. Clock/Flat Screen Receptacles

1. Single type receptacle with a recessed outlet clock hanger type mounting coverplate. 125V/15A/2P/3W/G - NEMA 5-15R type.
2. Manufacturer
   a. Leviton 5320-* Series
   b. Hubbell RR151CH Series

D. Maintained Contact Switches

1. Provide toggle operated switches SPST, DPST, 3-way or 4-way operation as indicated. 120V/15A rating, quiet type, maintained contact, and a green hexagonal ground screw or ground pigtail, back and side wired.
2. Manufacturer
   a. Leviton 1451-2 (Color to match receptacles)
   b. Hubbell RS115 Series

E. Maintained Contact Slider Type Switch (For Multi-Ganging with Dimmers)

1. Slide-operated switch (to match dimmer), single pole, 3-way or 4-way operation as indicated, 120/277V, 20A rating.
2. Manufacturer
   a. Leviton Monet Series
   b. Lutron Nova T Series

F. Slider Type Wall Box Dimmers

1. Slide operated AC incandescent solid state type dimmer with positive ON/OFF switching, integral surge protection, voltage stabilized output, RFI filtered and maximum lighting level adjustment. 120V/60Hz, unless noted otherwise, with lettering and/or nameplate as indicated. Dimmers shall have lowest profile available (wattage permitting).
2. Manufacturer

	Load Type				
	Incandescent/ halogen	Dimmable CFL/LED (screw base)	Magnetic low voltage	Electronic low voltage	0-10V Fluorescent/ LED
Lutron Nova T Series	NT-600-XX	NTCL-253P-XX	NTLV-600-XX	NTELV-600-XX	NTSTV-DV-XX
Leviton SureSlide Series	6673-10X	6672-1LX	6611-PX	6615-P0X	

Leviton Renoir Series					AWSMG-7DW

G. Illuminated Toggle Switches

1. Single pole, 3-way or 4-way, as indicated, conforming to UL #20, NEMA #WDI-3.02 and F.S. #W-S-896E. 120V/20A rating, quiet type, maintained contact, and a green hexagonal ground screw or ground pigtail, back and side wired. Lighted toggle to glow when switch is off.
2. Manufacturer
   a. Leviton 1461-LHC
   b. Hubbell HBL1221L*Series

H. Tamper-Resistant Receptacles

1. All 125-volt, 15- and 20-amp receptacles in a dwelling unit shall be listed tamper-resistant receptacles.

I. Weather-Resistant Receptacles

1. All 15- and 20-amp receptacles installed in damp or wet locations shall be listed weather-resistant type.

J. Tamper-Resistant Receptacle with USB Chargers

1. Device shall include two 15-amp tamper-resistant receptacles and two 5-volt DC USB 2.0 and 3.0 compatible charging ports.
2. Where shown on drawings as ground-fault protected, device shall be wired from load-side of a GFCI receptacle.
3. Manufacturer
   a. Hubbell USB15ACPD*
   b. Pass & Seymour TM826USB*CC6

2.3 COVERPLATE DESCRIPTION AND MANUFACTURER – COVERPLATES

A. Flush Mounted Interior Receptacle/Switch Coverplates

1. Single or multi-gang to match device type. Medium size (4-7/8" min.), standard depth, smooth finish with thermoplastic material.
2. Color to match device color.
3. Coverplates in mechanical/electrical equipment rooms and high abuse areas shall be stainless steel, non-magnetic.
4. Coverplates flush mounted in exposed masonry construction shall be jumbo type.
5. Manufacturer
   a. Hubbell ~~N~~PJ Series (thermoplastic)
   b. Hubbell SSJ Series (stainless steel)

B. Weatherproof Device Coverplates

1. Provide weatherproof “in use” cast aluminum lockable covers. Plastic covers are allowed on dwelling balconies.
   a. Hubbell WP Series
   b. Thomas & Betts Russell Stoll Series

C. Multi-Outlet Raceway

1. Product Description
   a. Two-piece rectangular surface raceway of length as prescribed. Stainless steel type 304 housing complete with all bends, fittings, couplings, caps and mounting hardware.
   b. Single 15A/125V grounding outlets UL Labeled and full length ground wire.
   c. Outlets 18" on centers starting no less than 9" from end.
   d. Maximum of six outlets per circuit. Where two or more circuits are utilized the outlets shall be on alternate circuits.
2. Manufacturers
   a. Walker/Wiremold
   b. Hubbell

2.4 MISCELLANEOUS ITEMS

A. Time Switches

1. Electronic Astronomical Schedule Type
   a. 365 day scheduling, solid state, skip-a-day feature, daylight saving changeover, leap year adjusted with capacitor backup, DPDT-120V/20A rated contacts, light sensor input.
   b. Acceptable Manufacturer
      1) Tork DZS Series (channels as required)

B. Photoelectric Control Switches

1. Product Description
   a. Raintight photoelectric self-contained control for switching.
   b. Die-cast housing with adjustable sensor.
2. Manufacturers
   a. AMF/Paragon
   b. Tork 2100 Series

C. Lighting Contactor

1. Product Description
   a. Multi-pole contactor for switching branch circuit tungsten and ballast lighting and resistant heating loads.
   b. Number of poles as indicated (paralleling multiple contactors is acceptable), poles rated for 20 amperes @ 600V continuous duty.
   c. Mechanically held contactor with coil clearing contacts, operating coil voltage to match circuit characteristics.
   d. Housed in panelboard (if indicated).

D. Poke-thru Floor Devices

1. Product Description
   a. Refer to drawings for specific features.
   b. Device shall meet UL 514A requirements for scrubwater test standards.
2. Manufacturer
   a. Hubbell
   b. Walker/Wiremold
   c. Thomas & Betts/Steel City

E. Single/Multiple Station Smoke Alarms: Each sleeping room shall be provided with a smoke alarm. Alarms shall be 120V (with battery back-up) with built-in evacuation horn, power-on indicator and auxiliary contact. Where more than one is installed in a dwelling unit, activation of one detector shall trigger all alarms in that unit. Alarms shall have integral alarm silencing feature.

F. Single/Multiple Station Combination Smoke/Carbon Monoxide Alarms: Each area outside of a sleeping room shall be provided with a combination smoke/carbon monoxide alarm. Alarms shall be 120V (with battery back-up) with built-in evacuation horn, power-on indicator and auxiliary contact. Where more than one is installed in a dwelling unit, activation of one detector shall trigger all alarms in that unit. Alarms shall have integral alarm silencing feature.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All dimmer circuits shall have dedicated neutrals.

B. Install decorative plates on switch, receptacle, and blank outlets when indicated.

C. Install devices and wall plates flush and level.

D. Coordinate the exact location of wiring devices with other trades and architectural features. Do not locate devices on two different architectural finishes such as half on wall tile and half on painted surface, unless noted otherwise.

E. Provide plaster rings in areas requiring them due to construction.

F. Where more than one device is indicated, arrange in gangs covered with one coverplate per manufacturer’s instructions.

G. Where dimmer(s) and switch(es) are shown adjacent to one another, switch(es) shall be a maintained contact switch matching dimmer style, so that a common, multi-gang faceplate can be used.

H. Provide 6" long ground wire from grounding lug to all switches and receptacles to a screw type bonding device on the conduit or outlet box.

END OF SECTION

SECTION 26 28 16

DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. All work specified herein shall be accomplished in accordance with the applicable requirements of Section 26 00 00 - Electrical General.

1.2 WORK INCLUDED

A. The work under this section shall include all labor, materials, accessories, services and equipment necessary to furnish and install disconnect switches, up to 1200 amps, complete, as indicated on the Drawings and as specified herein.

B. Equipment schedules and specifications are based on the one manufacturer listed in the schedule. Other manufacturers of equal quality and performance may be submitted to the Engineer for review. When substitution of equipment is made, the Contractor shall be responsible for the costs of any item and engineering and construction revisions necessary in his or any other contract or trade that may be required to satisfy plans and specifications.

C. This section includes fuses.

D. This section includes individually mounted enclosed switches used for the following:

1. Service disconnecting means.
2. Feeder and branch-circuit protection.
3. Motor and equipment disconnecting means.

1.3 SUBMITTALS

A. Product Data: For each type of switch and fuse accessory, and component indicated, include dimensions and manufacturer’s technical data on features, performance, electrical characteristics, ratings, and finishes.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NEMA AB 1, NEMA KS 1 and UL 98.

C. Comply with NFPA 70.

D. Comply with NEMA FU 1.

E. Source Limitations: Provide fuses from a single manufacturer.

1.5 COORDINATION

A. Coordinate layout and installation of switches and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer of fusible and non-fusible switches shall be Cutler-Hammer, General Electric, Siemens or Square D Company.

B. Manufacturer of fuses shall be Bussman, Gould Shawmutt or Littelfuse.

2.2 ENCLOSED SWITCHES

A. All disconnect switches shall be heavy duty type with lockable handles (general duty allowed for equipment serving dwelling units).

B. Enclosed, non-fusible switch: NEMA KS 1.

C. Enclosed, fusible switch, 800A and smaller: NEMA KS 1 with clips to accommodate specified fuses and interlocked with cover in closed position.

D. Furnish and install all safety type disconnecting switches indicated on the drawings, specified or required by the National and/or State Electrical Code. Switches shall be externally operable. If the size is not shown on the drawings, the subcontractor shall size the disconnect switch in accordance with name plate data of the equipment they serve.

E. Coordinate with other trades that may provide unit mounted disconnect switches prior to submission of bids.

F. Safety type disconnecting switches shall be heavy duty, 600 volt industrial type with quick-make, quick-break mechanism and interlocking cover which normally cannot be opened when the switch is in the “ON” position. Switches shall be single throw. Fusible switches shall be equipped with fuse clips to receive Bussman fuses. Switches shall have provision for padlocking in the open and closed positions. The operating handle shall be visible in either the on or off position.

G. All fused disconnect switches mounted above 6'-6" shall be hook stick operable.

H. Non-fused “pull-out” disconnects shall be allowed only for HVAC equipment serving dwelling units.

2.3 INTERIOR

A. Switch blades shall be operated by rotating shaft directly connected to the operating handle mechanism. Switch blades shall be clearly visible in the open position. All switches shall have clear shields over the incoming line lugs. Line shields shall be attached in such a way that switch blade covers or arc shields need not be removed for line installation. Line and load lugs shall be front removable and suitable for copper or aluminum, 60/75 degree wire through 200A sizes, 75 degrees C wire for 400-800A sizes.

B. Current limiting type RK1 dual element time delay fuses shall be furnished and installed as necessary; rating shall be shown on drawing.

2.4 ENCLOSURES

A. All switches shall have NEMA type 1 general purpose enclosures unless indicated otherwise on the drawings. NEMA 3R covers shall be side hinged rather than top hinged. NEMA 1 and 3R switches through 200A sizes shall tangential knockouts for conduit line up against walls. NEMA 12 enclosures through 200A sizes shall be UL Listed for conversion to NEMA 3R usage by opening a factory provided drain hole. All types of enclosures shall have metal nameplates affixed to the cover to show the switch type and rating and clearly indicate “ON” and “OFF” direction of handle movement. Provide hubs on all NEMA 4, 4X, or 3R type disconnects.

B. Provide manufacturer’s standard factory applied finish unless otherwise indicated.

C. Provide phenolic engraved nameplate for disconnect switches.

2.5 CONTROL POLE

A. Where required a direct action interlock or control pole shall be affixed to the switch base in such a manner as to operate positively and only with the opening and closing of the switch power poles.

2.6 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

B. Examine elements and surfaces to receive enclosed switches for compliance with installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Locate disconnect switches to provide working clearance and full accessibility as required by the National Electrical Code.

B. Mounting and Support

1. Mounting
   a. Enclosure shall be secured to structure by a minimum of four (4) fastening devices. A 1.5-inch minimum diameter round washer shall be used between head of screw or bolt and enclosure.
   b. Enclosure shall be mounted where indicated on the drawings or specified herein. Support from the structure with fastening device specified. Mount with operating handle at 60" AFF, unless other height is indicated.
   c. Attach enclosure directly to masonry, concrete, or wood surfaces.
   d. Mounted enclosure on metal channel (strut), which is connected to structure with fastening device.
   e. Where enclosure is not indicated on a wall or structure, construct a metal channel (strut) free standing frame secured to floor, pad, or other appropriate building structure.

C. Do not splice conductors in enclosure. Where required install junction box or wireway adjacent to enclosure and splice or tap conductors in box. Refer to number of conductors in a conduit limitation defined in the conductors and cables section of the Specifications and do not exceed.

3.3 CONNECTIONS

A. Install equipment grounding connections for switches with ground continuity to main electrical ground bus.

B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 CLEANING

A. On completion of installation, inspect interior and exterior of enclosures. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

B. Touch up paint all scratched or marred surfaces with factory furnished touch up paint of the same color as the factory applied paint.

END OF SECTION

SECTION 26 28 18

ENCLOSED CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. All work specified herein shall be accomplished in accordance with the applicable requirements of Section 26 00 00 - Electrical General.

1.2 WORK INCLUDED

A. The work required under this section of the Specifications consists of installation of enclosed circuit breakers up to 800 amps for use on systems 600 volts and below as indicated on the drawings. This Section includes individually mounted enclosed circuit breakers used for the following:

1. Service disconnecting means.
2. Feeder and branch-circuit protection.
3. Motor and equipment disconnecting means.

B. The work under this section shall include all labor, materials, accessories, services and equipment necessary to furnish and install enclosed circuit breakers, complete, as indicated on the Drawings and as specified herein.

C. Equipment schedules and specifications are based on the one manufacturer listed in the schedule. Other manufacturers of equal quality and performance may be submitted to the Engineer for review. When substitution of equipment is made, the Contractor shall be responsible for the costs of any item and engineering and construction revisions necessary in his or any other contract or trade that may be required to satisfy plans and specifications.

1.3 SUBMITTALS

A. Product Data: For each type of circuit breaker accessory and component indicated, include dimensions and manufacturer’s technical data on features, performance, electrical characteristics, ratings, and finishes.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NEMA AB 1, NEMA KS 1, UL 98, NEMA Standards Publication AB1-1975 and Federal Specifications W-C-375B classifications.

C. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate layout and installation of circuit breakers and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer of enclosed circuit breakers shall be Cutler-Hammer, General Electric, Siemens or Square D Company.

2.2 CIRCUIT BREAKERS

A. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity 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.

2.3 ENCLOSURES

A. NEMA 1 enclosures shall be fabricated from sheet steel with ANSI 49 gray baked enamel finish. Knockouts shall be provided in enclosures for circuit breakers through 225A frame sizes. Enclosures shall be provided with a means to padlock the circuit breaker in the OFF position.

B. NEMA 3R enclosures shall be fabricated from galvanically treated steel with ANSI 49 gray baked enamel finish. Enclosures for circuit breaker through 225A frame sizes shall have provisions for interchangeable conduit hubs. Enclosures shall be provided with a means to padlock the plate-type cover closed.

C. Provide manufacturer’s factory applied finish unless otherwise indicated.

D. Provide phenolic engraved nameplate for circuit breakers.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed circuit breakers for compliance with installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Locate enclosed circuit breakers to provide working clearance and full accessibility as required by the National Electrical Code.

B. Mounting and Support

1. Mounting
   a. Enclosure shall be secured to structure by a minimum of four (4) fastening devices. A 1.5" minimum diameter round washer shall be used between head of screw or bolt and enclosure.
   b. Enclosures shall be mounted where indicated on the drawings or specified herein. Support from the structure with fastening device specified. Mount with operating handle at 60" AFF, unless other height is indicated.
   c. Attach enclosure directly to masonry, concrete, or wood surfaces.

d. Mounted enclosure on metal channel (strut), which is connected to structure with fastening device.
e. Where enclosure is not indicated on a wall or structure, construct a metal channel (strut) free standing frame secured to floor, pad, or other appropriate building structure.

C. Do not splice conductors in enclosure. Where required install junction box or wireway adjacent to enclosure and splice or tap conductors in box. Refer to number of conductors in a conduit limitation defined in the conductors and cables section of the Specifications and do not exceed.

3.3 CONNECTIONS

A. Install equipment grounding connections for circuit breakers with ground continuity to main electrical ground bus.

B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 CLEANING

A. On completion of installation, inspect interior and exterior of enclosures. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

B. Touch up paint all scratched or marred surfaces with factory furnished touch up paint of the same color as the factory applied paint.

END OF SECTION

SECTION 26 43 13

SURGE PROTECTIVE DEVICES (SPD)

PART 1 - GENERAL

1.1 DESCRIPTION

A. These specifications describe the electrical and mechanical requirements for a hybrid high-energy power conditioning filter incorporating surge protective devices and high-frequency electrical line noise filtering. The specified unit shall provide effective high-energy surge protection, surge current diversion, high-frequency attenuation, and line control in ANSI/IEEE C62.41.1-2002 environments connected on the load side of the facility's meter or main overcurrent device. The unit shall be connected in parallel with the facility's wiring system.

1.2 QUALITY ASSURANCE

A. The requirements of the following standards shall become a part of this Specification by reference:

1. American National Standards Institute and Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.41.1-2002, C62.41.2-2002, and C62.45-2002)
2. Canadian Standards Association (CSA)
3. Federal Information Processing Standards Publication 94 (FIPS PUB 94)
4. National Electrical Manufacturers Association (NEMA)
5. National Fire Protection Association (NFPA 70 (NEC), 75 and 78)
6. Underwriters Laboratories Inc. (UL 1449 Current Edition and 1283)

The unit shall be UL and cUL 1449 Current Edition Listed as a Surge Protective Device.

B. Acceptable Manufacturers

1. Current Technology
2. Thor Systems
3. Square D by Schneider Electric

C. Testing: The unit shall be thoroughly factory-tested before shipment. Testing of each unit shall include, but shall not be limited to, quality assurance checks, MCOV and clamping voltage verification tests.

D. Warranty: The manufacturer shall provide a minimum 5-year warranty from date of shipment against failure when installed in compliance with applicable national/local electrical codes and the manufacturer's installation, operation and maintenance instructions.

E. Submittal Documentation: Documentation of unit's UL 1449 Voltage Protective Rating (VPR) shall be included as required product data submittal information. Manufacturer shall make available upon request certified documentation of applicable Location Category Testing in full compliance with ANSI/IEEE C62.41.1-2002, C62.41.2-2002, and C62.45-2002 Guidelines. The manufacturer shall furnish an equipment manual with installation, operation, and maintenance instructions for the specified unit. Electrical and mechanical drawings shall be provided by the manufacturer which show unit dimensions, weights, mounting provisions, connection details and layout diagram of the unit.

PART 2 - PRODUCTS

2.1 GENERAL MATERIALS REQUIREMENT

A. The unit shall provide all modes of protection: line to neutral, line to ground, and neutral to ground.

B. High Frequency Tracking Filter: The unit shall include a UL1283 high-frequency extended range tracking filter. The filter shall reduce fast rise-time, high-frequency, error producing transients and electrical line noise to harmless levels, thus eliminating disturbances which may lead to system upset.

C. Unit Status Indicators: The unit shall include solid-state, long-life, externally mounted LED visual status indicators that indicate the status of MOV fusing.

D. Transient Counter: Front cover mounted transient counter (LCD or LED) shall totalize surges for all modes.

E. Nominal discharge current rating shall be I_n 20 kA.

F. Minimum SPD fault current ratings shall be 100Kaic.

G. Single Impulse Test – SPD shall be tested by a nationally recognized, independent test laboratory to determine the maximum surge capability. The test shall include a pre-test impulse, followed by the single impulse at rated surge current, followed by a post-test impulse. Compliance is achieved per ANSI/IEEE Std. C62.72-2016 (Clause 13.2) section A. which states no damage or degradation to the SPD with the operation of an internal or external SPD [safety] disconnector. Testing on individual modules is not acceptable.

H. Minimum Repetitive Impulse Test - The SPD shall be endurance tested to withstand 10kA [8x20µs], 20kV [1.2x50µs], IEEE C62.41 Category C surge current with less than 10% degradation of clamping voltage. The minimum number of surges the unit shall be able to protect against is as follows:

1. Service Entrance devices: impulses 15,000 per mode
2. Distribution Panel devices: impulses 10,000 per mode

I. IEEE Waveform Let Through Test – Manufacturer must provide performance data in all available modes using the standard IEEE C62.41.2 waveforms which include Category A3 and B3 ring wave and Category B3 Low, B3 High/C1 Low and C3 High combination waves. Providing average values for each L-N, L-G, N-G, L-L tested is acceptable.

PART 3 - APPLICATIONS

3.1 SERVICE ENTRANCE/MAIN DISTRIBUTION APPLICATIONS

A. The following table will indicate appropriate model numbers based on the electrical system ampacity. Surge current ratings are based on the Site Shield Risk Assessment Spreadsheet (TSI 067 3gSSH/r3).

B. SPDs connected to service equipment shall be listed as a type 1 SPD per UL1449 and shall have integral disconnect switch, and shall be connected to bus on the load side of the main switch.

SERVICE ENTRANCE/MAIN DISTRIBUTION APPLICATIONS					
Manufacturers' Models			Electrical System Ampacity @ SPD Install Point	Surge Protection (kA)	
Current Tech	Thor Systems	Square D		Per Mode	Per Phase
TG 300	TSrc 300	EMB 60	4000 – 6000A	300	600
TG 250	TSrc 250	EMB 50	2000 – 3000A	250	500
TG 200	TSrc 200	EMB 50	1200 – 1600A	200	400
TG 150	TSrc 150	EMB 30	600 – 1000A	150	300

TG 100	TSrc 100	EMB 20	125 – 400A	100	200

3.2 PANELBOARDS AND BRANCH PANEL APPLICATIONS

A. As indicated on the Drawings, provide a panelboard with externally mounted SPD with high-frequency filtering per requirements listed in this specification. Provide number of breakers, voltage/phases as indicated on the Drawings. SPD shall physically connect to the top or bottom of panelboard allowing for SPD to be repaired or replaced without opening the dead front of the panelboard.

B. SPDs connected to Panelboards or Branch Panels shall be listed as a type 1 or type 2 SPD per UL1449 and shall be circuit breaker connected.

C. The following table indicates appropriate model numbers based on the electrical system ampacity. Surge current ratings are based on Site Shield Risk Assessment Spreadsheet (attached #TSI 067 3gSSH/r3). SPDs connected to Panelboards and Branch Panels shall be listed as a type 1 or type 2 SPD per UL 1449 and shall be 30 Amp circuit breaker connected.

PANELBOARDS AND BRANCH PANEL APPLICATIONS					
Manufacturer/Model Nos.			**Electrical System Ampacity @ SPD Install Point**	**Surge Protection (kA)**	
Current Tech	**Thor Systems**	**ASCO**		**Per Mode**	**Per Phase**
EGPE2 150	TSnc 150	EMD 30	600A	150	300
EGPE2 100	TSnc 100	EMD 30	125 – 400A	100	200
EGPE2 60	TSnc 050	EMD 30	Up to 100A	50	100

PART 4 - EXECUTION

4.1 INSTALLATION

A. Install wiring connection to distribution system as indicated on the Drawings. Wiring length should be kept to an absolute minimum (3' or less) and be as straight as possible.

B. Wire sizes to Service Entrance/Main Distribution SPD should be 4#6, 1#6 G - 1" conduit.

C. Wire sizes to Panelboard and Branch Panel SPD should be as indicated 4#10, 1#10G – ¾" conduit.

END OF SECTION

SECTION 26 51 00

LIGHTING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the lighting system requirements.

B. All fixtures shall be current source, provided with lamps ready to use.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Refer to another division for the ceiling systems.

B. Lighting system shall be coordinated with the ceilings.

1.3 SUBSTITUTIONS/VALUE ENGINEERING/PRICING

A. Substitution/value engineering requests shall be accompanied by complete manufacturer's data with model numbers, cut sheets with options indicated, and a full photometric report. For exterior lighting, a computer generated point-by-point calculation shall be provided.

B. All substitution requests shall be submitted in completion to Engineer at least 10 days prior to bid date.

C. Pricing for lighting fixtures shall be separate from pricing for lighting controls (occupancy sensors, relay controls, dimming).

PART 2 - PRODUCTS

2.1 DRIVERS AND BALLASTS

A. Electronic driver for LED luminaires:

1. Operation Voltage: The luminaire shall operate from a 60 HZ ±3 HZ AC line over a voltage ranging from 120-277 VAC and 347 VAC. All drivers shall not utilize step down transformers to achieve operating voltage. The fluctuations of line voltage shall have no visible effect on the luminous output.
2. Operational Performance: The driver and LED circuitry shall prevent visible flicker to the unaided eye over the voltage range specified above.
3. RF Interference: LED Drivers must meet Class A emission limits referred in Federal Communications Commission (FCC) Title 47, CFR Part 15, class A regulations concerning the emission of electronic noise.
4. Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 20 percent.

2.2 LAMPS

A. LED lamps shall be 3,500 degrees K, CRI 75. Size and wattage shall be as specified by the manufacturer of fixture with LED wattages taken as equivalent to incandescent where applicable. They shall be General Electric or equal as manufactured by Sylvania or Philips unless indicated otherwise on Drawings.

2.3 LIGHTING FIXTURES

A. Letter designations beside outlet symbols on Drawings correspond to letter designations in Lighting Fixture Schedule.

B. Recessed fixtures, where used in an insulated ceiling, shall be equipped with thermal protection and shall bear the UL Label indicating the suitability for such use.

C. Lens material for recessed fixtures shall be 100% virgin acrylic, 0.125" thick in a square prism pattern similar to KSH-K-12 or as scheduled in Lighting Fixture Schedule.

D. Site lighting poles shall meet or exceed the local wind loading requirements of authority having jurisdiction.

E. Concrete pole bases shall be required for site lighting poles.

F. Recessed lighting fixtures installed in the building thermal envelope (e.g. attic) shall be IC rated and labeled with enclosures that are sealed and gasketed to limit air leakage between conditioned and non-conditioned spaces.

G. Recessed lighting fixtures that penetrate the membrane of a rated ceiling/floor assembly shall be either listed and labeled, or installed within an enclosure, so that the ceiling rating is maintained. Rated enclosures shall be by Fire Rated Product Specialties (FRPS) or approved equal.

2.4 LED LUMINAIRES

A. Each Luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply). Drivers shall have 2.5kVA surge protection.

B. Reported lumen maintenance shall be greater than 86% per TM-21-11 after 60,000 hours of luminaire operation in an ambient environment of 25ºC (77ºF). This data must be TM-21 compliant and derived from the EnergyStar.gov TM-21 Calculator.

C. The individual LEDs shall be constructed such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire.

D. Each luminaire shall be listed with Underwriters Laboratory, Inc. under UL1598 for luminaires, or an approved equivalent standard from a nationally recognized testing laboratory.

E. The color rendition index (CRI) shall be a nominal 80 for interior lighting and a nominal 70 for exterior lighting.

F. 5 Year warranty minimum

G. Luminaire shall be tested to LM-79, LM-80 and TM-21 standards

H. The luminaire shall have a power factor of 0.9 or greater.

PART 3 - EXECUTION

3.1 LIGHTING FIXTURES

A. Provide lighting fixtures at all locations indicated by distinctive symbols or notes on the Drawings.

B. Lighting fixtures shall be secured to ceiling grid with clips or screws and two #12 steel wires mounted to opposite corners of light fixture secured to structure.

C. Locations of lighting fixtures on the electrical drawings are approximate. Refer to Architectural reflected ceiling plan for actual locations of fixtures and mounting heights.

D. Lighting fixtures installed in plaster and stucco ceiling shall have plaster frame and shall be of the flanged type.

E. Fixtures recessed in concealed-spline tile and in gypsum board ceilings shall be flanged.

F. Surface or recessed fixtures in or on plastered ceilings shall be supported from pieces of support channel spanning across the main supporting channels and shall not depend on the metal lath for support.

G. Each recessed lighting fixture shall have a trim to match the type of ceiling (exposed grid, metal panel, etc.) in which it is being installed, except where noted otherwise on the plans.

H. Each lighting fixture recessed in a concrete wall shall have a junction box or wiring compartment provided inside the fixture housing. Provide conduit access into the fixture concealed.

END OF SECTION

SECTION 27 00 00

COMMUNICATIONS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 01 General Requirements shall be considered a part of this section and shall have the same force as if printed herein full.

1.2 QUALITY ASSURANCE

A. Specifications, Standards and Codes: All work shall be in accordance with the following:

1. The 2023 edition of the National Electrical Code (NFPA 70)
2. The latest adopted edition of the Life Safety Code (NFPA 101)
3. The 2021 edition of the International Fire Code (IFC)
4. The 2021 edition of the National Fire Alarm and Signaling Code (NFPA 72)
5. The latest adopted edition of the Standard for Emergency Services Communications (NFPA 1225).
6. The 2021 edition of the International Building Code
7. Building Industry Consulting Service International (BICSI)
8. Telecommunications Distribution Methods Manual (TDMM)
9. American National Standards Institute (ANSI)
10. The National Electrical Safety Code (NESC)
11. The National Electrical Safety Code (ANSI C-2)
12. National Electrical Manufacturers Association (NEMA)
13. Telecommunications Industries Association (TIA)
14. Electronic Industries Association (EIA)
15. Institute of Electrical & Electronics Engineers (IEEE)
16. Underwriters Laboratories (UL)
17. American Standards Association (ASA)
18. Federal Communications Commission (FCC)
19. Occupational Safety and Health Administration (OSHA)
20. American Society of Testing Material (ASTM)
21. Americans with Disabilities Act (ADA)
22. Local city and county ordinances governing electrical work.
23. In the event of conflicts, the more stringent provisions shall apply.

1.3 SCOPE

A. The work to be performed under this section of the Specifications shall include all labor, material, equipment, and tools required for the complete installation of the work indicated on the Drawings and as specified herein.

B. All materials that are a part of the Communications Infrastructure and necessary to its proper operation, but not specifically mentioned and shown on the Drawings, shall be furnished and installed without additional charge.

C. The Drawings and Specifications are complementary to each other and what is called for by one shall be as binding as if called for by both. If a discrepancy exists between the Drawing and Specifications, the higher cost shall be included, and the engineer shall be notified of the discrepancy.

SECTION 27 00 00

COMMUNICATIONS

1.4 WORK INCLUDED

A. The Communications Infrastructure installed and work performed under this Division of the Specifications shall include but not necessarily be limited to the following:

1. Firestopping
2. Grounding and Bonding
3. Communications Pathways, Underground Ducts and Raceways
4. Identification and Labeling
5. Commissioning
6. Communications Entrance Protection
7. Communications Cabinets, Racks and Enclosures
8. Communications Termination Blocks and Patch Panels
9. Cable Management and Ladder Racks
10. Communications Rack Mounted Power Protection and Power Strips
11. Structured Media Enclosures
12. Voice/Data Cabling Infrastructure
13. CATV Cabling Infrastructure
14. Copper, Fiber Optic, and Coaxial Backbone Cabling
15. Copper, Fiber Optic, and Coaxial Horizontal Cabling
16. Communications Faceplates and Connectors
17. Communications Patch Cords and Station Cords
18. Wireless Access Points
19. Public Safety Distributed Antenna Systems (PS DAS/ERRC)
20. Underground Raceway Excavation, Backfill and Compaction
21. Concrete Work for Duct Banks, Maintenance Holes, Handholes, Vaults and Restoration

1.5 DEFINITIONS

A. Terms: The following definitions of terms supplement those of the General Requirements and are applicable to Division 27 - Communications:

1. Provide: As used herein shall mean “furnish, install and test (if applicable) complete.”
2. Infrastructure: As used herein shall mean cable, conduit, raceway, cable tray or j-hooks with all required boxes, fittings, connectors, and accessories; completely installed.
3. Work: As used herein shall be understood to mean the materials completely installed, including the labor required.

1.6 DRAWINGS

A. Drawings are generally diagrammatic and show the arrangement and location of pathways, outlets, support structures and equipment. The Contractor shall coordinate the structural and finish conditions affecting his work and arrange his work accordingly. Should conditions on the job make it necessary to make adjustments to pathways or materials, the Contractor shall so advise the Engineer and secure approval before proceeding with such work.

B. Where exact locations are required by equipment for stubbing-up and terminating conduit concealed in floor slabs, the Contractor shall provide shop drawings, equipment location drawings, foundation drawings, and any other data required to locate the concealed conduit before the floor slab is poured.

C. Materials, equipment, or labor not indicated but which can be reasonably inferred to be necessary for a complete installation shall be provided. Drawings and Specifications do not undertake to indicate every item of material, equipment, or labor required to produce a complete and properly operating installation.

D. The right is reserved to make reasonable changes in locations of equipment indicated on Drawings prior to rough-in without increase in contract cost.

E. The Contractor shall not reduce the size or number of conduit runs indicated on the Drawings without the written approval of the Engineer.

F. Any work installed contrary to Contract Drawings shall be subject to change as directed by the Engineer, and no extra compensation will be allowed for making these changes.

G. The location of equipment, support structures, outlets, and similar devices shown on the Drawings are approximate only. Do not scale Drawings. Obtain layout dimensions for equipment from Architectural plans unless otherwise noted.

H. Schematic diagrams shown on the Drawings indicate the required functions only. The technology of a particular manufacturer may be used to accomplish the functions indicated without exact adherence to the schematic Drawings shown. Additional labor and materials required for such deviations shall be furnished at the Contractor's expense.

I. Verify the ceiling type, ceiling suspension systems, and clearance above hung ceilings prior to ordering cabling and associated hardware. Notify the Engineer of any discrepancies.

J. Review all architectural drawings for modular furniture.

K. Portions of these Drawings and Specifications are abbreviated and may include incomplete sentences. Omissions of words or phrases such as "the Contractor shall," "shall be," "as indicated on the Drawings," "in accordance with," "a," "the" and "all are intended" shall be supplied by inference.

1.7 SUBMITTALS

A. Provide submittals for the following systems:

1. Firestopping
2. Grounding and Bonding
3. Communications Pathways, Underground Ducts and Raceways
4. Identification and Labeling
5. Commissioning
6. Communications Entrance Protection
7. Communications Cabinets, Racks and Enclosures
8. Communications Termination Blocks and Patch Panels
9. Cable Management and Ladder Racks
10. Communications Rack Mounted Power Protection and Power Strips
11. Structured Media Enclosures
12. Voice/Data Cabling Infrastructure
13. CATV Cabling Infrastructure
14. Copper, Fiber Optic, and Coaxial Backbone Cabling
15. Copper, Fiber Optic, and Coaxial Horizontal Cabling
16. Communications Faceplates and Connectors
17. Communications Patch Cords and Station Cords

18. Wireless Access Points
19. Public Safety Distributed Antenna Systems (PS DAS/ERRC)
20. Underground Raceway Excavation, Backfill and Compaction
21. Concrete Work for Duct Banks, Maintenance Holes, Handholes, Vaults and Restoration

B. Submit for approval, details of all materials, equipment, and systems to be furnished. Work shall not proceed without the Owner and/or the Project Manager's approval of the submitted items.

1. Submittals for individual systems and equipment assemblies that consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered, reviewed, or stored, and such submittals will not be returned except at the request and expense of the Contractor.
2. Contractor shall generate shop drawings. Modify reviewed and accepted shop drawings to include revisions based upon completion of work. Submit shop drawings with record drawings on hard copy.
3. Shop drawings shall include equipment racks, patch panels, termination blocks, connection details, rack mounting details and any other details not included in the construction drawings.

C. Any materials and equipment listed that are not in accordance with Specification requirements may be rejected.

D. The approval of material, equipment, systems, and shop drawings is a general approval subject to the Drawings, Specifications, and verification of all measurements at the job. Approval does not relieve the Contractor from the responsibility of shop drawing errors. The Contractor shall carefully check and correct all shop drawings prior to submission for approval.

E. Materials List: Submit a complete materials list indicating all equipment to be provided as part of this section.

F. Samples: Submit selection and verification samples of finishes, colors, and textures as requested.

G. Complete details of equipment mounting configuration.

H. Manufacturing assembly and testing procedures and forms.

I. Installation testing and check out procedures and forms to be used by the Contractor and Architect and/or Consultant.

J. The conduit plans, equipment plans, riser diagrams, block diagrams and details are to be submitted in the latest version of Revit or AutoCAD and shall be submitted on a minimum of 'D' size drawings. Documents submitted in any other manner including marked up sets of the bid documents shall receive immediate rejection and will not be reviewed. A complete, electronic set of as-built documents will be issued at the completion of the project.

K. Submittals issued in a manner inconsistent with the requirements of these specifications shall receive immediate rejection and will not be reviewed. Submittals issued containing materials, products and/or equipment that is not listed or approved by addendum shall receive immediate rejection and will not be reviewed.

1.8 QUALITY ASSURANCE

A. Equipment and materials required for installation under these Specifications shall be the current model and new (less than one [1] year from the date of manufacture), unused and without blemish or defect.

B. Equipment shall bear labels attesting to Underwriters Laboratories, where subject to label service. Manufacturers of equipment and materials pertinent to these items shall have been engaged in the manufacture of said equipment a minimum of three (3) years and, if so directed by the Owner, be able to furnish proof of their ability by submitting affidavits and descriptive data about their product including size and magnitude comparable to requirements specified herein.

1.9 CONTRACTOR QUALIFICATIONS

A. The Contractor shall have total responsibility for the coordination and installation of the work shown and described in the Drawings and Specifications. The Contractor shall be a company specializing in the design, fabrication, and installation of integrated communications systems.

B. Communications Systems specified shall be installed under the direction of a qualified Contractor. Qualification requirements shall include submittal by the Contractor to the Architect of the following:

1. List of previous projects of this scope, size and nature; including names and sizes of projects, description of work, time of completion and names of contact persons for reference.
2. Shall certify that they are manufacturer-authorized for work to be performed.

C. Contractor must employ at least one (1) full-time Registered Communications Distribution Designer (RCDD).

1.10 COORDINATION WITH OTHER TRADES

A. The Contractor shall coordinate Communications work with that of other sections as required ensuring that the entire communications work will be carried out in an orderly, complete, and coordinated fashion.

1.11 SITE INVESTIGATION

A. Prior to submitting bids of the project, visit the site of the work to become aware of existing conditions that may affect the cost of the project. Where work under this project requires extension, relocation, reconnections or modifications to existing equipment or systems, the existing equipment or systems shall be restored to their original condition before the completion of this project.

1.12 PERMITS

A. Obtain all permits and inspections for the installation of this work and pay all charges incident thereto. Deliver to the Owner all certificates of said inspection issued by authorities having jurisdiction.

1.13 RENOVATIONS AND ADDITIONS

A. All work that would adversely affect the normal operation of the other portions of the Owner's property shall be done at a time other than normal working hours. Normal working hours shall be considered 8 a.m. to 5 p.m. Monday through Friday.

B. Prior to submitting bids on the project, visit the site of the work to become aware of existing conditions that may affect the cost of the project.

C. Where work under this project requires extension, relocation, reconnections or modifications to existing equipment or systems, the existing equipment or systems shall be restored to their original and operating condition. Remove all equipment indicated to be demolished, including outlets, devices, raceways, and support structures.

D. Care shall be exercised in the removal and storage of equipment indicated to be relocated or removed and reused. Prior to placing back into service, equipment shall be cleaned and marred or chipped paint surfaces touched-up.

E. Provide all coring, cutting, and patching to existing walls, floors, etc., required for the removal of existing work or the installation of new work.

1.14 OPERATION & MAINTENANCE MANUALS

A. The Contractor shall furnish two (2) hard copies and one electronic copy of operational and maintenance manuals for all systems furnished. The manuals shall include component lists, instructions for care, operation instructions, instructions for ordering replacement equipment and personnel to contact for warranty work.

1.15 APPROVALS

A. Deviations from this specification must be documented in writing to the Architect and Engineer at least twenty-one (21) business days prior to the bid date.

B. Complete catalogue data, product specifications and technical information on alternative equipment must be provided including all associated cost savings or additions, including but not limited to equipment, equipment installation, power wiring and materials, programming, documentation, and project management.

1.16 DELIVERY & HANDLING

A. General: Comply with Division 1 Product Requirements Section.

B. Delivery: Deliver material in manufacturer's original, unopened, undamaged containers with identification labels intact.

C. Storage and Protection: Store materials and equipment in an area protected from harmful weather conditions and at temperature conditions recommended by manufacturer. After initial installation, protect equipment from exposure to dust, dirt, paint, and other contaminants.

1.17 PROJECT CONDITIONS

A. Field Measurements: Verify actual measurements/openings by field measurements before fabrication; show recorded measurements on shop drawings.

B. Scheduling: Coordinate taking field measurements, fabrication schedule and deliveries with construction progress schedule to avoid construction delays.

1.18 WARRANTY

A. Warranty: All equipment and labor provided under this section is warranted for two (2) years from Substantial Completion or System Commissioning, whichever occurs first.

B. During the warranty period, the Contractor shall perform quarterly preventative maintenance inspections on all installed equipment.

C. Nothing in the above warranty shall apply to material which has been misused or abused as follows: neglect by the owner, defects or damage caused by work or failure of work by others, ordinary wear or normal equipment adjustment.

D. Additionally, any unauthorized modifications, repairs or tampering shall constitute termination of the warranty.

1.19 TRAINING

A. The Contractor shall provide four (4) hours of on-site training for operational purposes and forty (40) hours of training for maintenance purposes at the turnover of the project.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

A. Where equipment is identified by manufacturer and catalog number, it shall be as the base of requirements for quality and performance. Where manufacturers for equipment are identified by name, the Contractor may submit for approval, similar equipment of other manufacturers as substitution. The Engineer's decision as to whether the submitted equipment is acceptable shall be final and binding.

B. All changes necessary to accommodate the substituted equipment shall be made at the Contractor's expense and shall be as approved by the Engineer. Detailed drawings indicating the required changes shall be submitted for approval at the time the substitution is requested.

C. If substitutions are made in lieu of device specified; form, dimension, design, and profile shall be submitted to the Engineer for approval.

D. Submit request for approval of substitute materials in writing to the Architect at least ten (10) days prior to bid opening.

2.2 MATERIALS

A. All materials used in this work shall be new and shall bear the inspection label of Underwriters' Laboratories Inc. or certification by other recognized laboratory.

B. The published standards and requirements of the Telecommunications Industries Association (TIA), National Electrical Manufacturers Association (NEMA), the American National Standard Institute (ANSI), the Institute of Electrical and Electronic Engineers (IEEE), and the American Society of Testing Materials (ASTM), are made a part of these Specifications and shall apply wherever applicable.

C. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts are available.

D. When more than one unit of the same class of equipment or material is required, such units shall be the products of a single manufacturer or partner manufacturers that offer a certified solution.

E. Components of an assembled unit need not be products of the same manufacturer but must offer a certified end-to-end solution.

F. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.

G. Components shall be compatible with each other and with the total assembly for the intended service.

PART 3 - EXECUTION

3.1 EXAMINATION OF CONDITIONS

A. Prior to the start of work, the Contractor shall carefully inspect the installed work of other trades and verify that such work is complete to the point where installation may properly commence. Start of work indicates acceptance of conditions.

B. Install equipment in accordance with applicable codes and regulations, and the referenced standards.

C. In the event of a discrepancy, immediately notify the Project Manager.

D. Do not proceed with installation until unsatisfactory conditions and discrepancies have been fully resolved.

3.2 PROTECTION OF SYSTEMS AND EQUIPMENT

A. Protect materials and equipment from damage during storage at the site and throughout the construction period. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, theft, moisture, extreme temperature, and rain.

B. Damage from rain, dirt, sun and ground water shall be prevented by storing the equipment on elevated supports and covering the sides with securely fastened protective rigid or flexible waterproof coverings.

C. During installation, equipment shall be protected against entry of foreign matter on the inside and be vacuum cleaned both inside and outside before testing, operating, or painting.

D. As determined by the Project Manager, damaged equipment shall be fully repaired or shall be removed and replaced with new equipment to fully comply with requirements of the Contract Documents.

E. Damaged paint on equipment and materials shall be repainted with painting equipment and finished with the same quality of paint and workmanship as used by the manufacturer.

3.3 ACCESS TO EQUIPMENT

A. Equipment shall be installed in location and manner that will allow access for maintenance and inspection.

B. Working spaces shall be not less than specified in the National Electrical Code (NEC/NFPA 70) for voltages specified.

C. Where the Project Manager determines that the Contractor has installed equipment not accessible for operation and maintenance, equipment shall be removed and reinstalled as directed by the Project Manager, at no additional cost to the Owner. "Accessible" is defined as being capable of being reached without the use of ladders or without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping, and duct work.

3.4 CLEANING

A. During construction, and prior to Owner acceptance of the building, remove from the premises and dispose of packing material and debris caused by communications work.

B. Remove dust and debris from interiors and exteriors of components. Clean accessible current carrying elements prior to being energized.

C. General: Upon completion of the work, remove excess dust & debris, materials, equipment, apparatus, tools, and similar items. Leave the premises clean, neat, and orderly.

3.5 COMPLETION

A. Results Expected: Systems shall be complete and operational, and controls shall be set and calibrated. Testing, start-up, and cleaning work shall be complete.

B. Maintenance Materials: Special tools for proper operation and maintenance of the equipment provided under this Specification shall be delivered to the Owner.

3.6 TESTING AND VERIFICATION

A. See specific Division 27 sections for testing parameters of sub-systems.

B. The Contractor shall verify that requirements of this Specification are met. Verification shall be through a combination of analyses, inspections, demonstrations, and tests, as described below.

C. Verification by inspection includes examination of items and comparison of pertinent characteristics against the qualitative or quantitative standard set forth in the Specifications. Inspection may require moving or partially disassembling the item to accomplish the verification, included as part of the work at no additional cost to the Owner.

D. The Contractor shall verify by demonstrations and/or tests that the requirements of this Specification have been met. The Contractor shall demonstrate that the communications systems, components, and subsystems meet Specification requirements in the "as-installed" operating environment during the "System Operation Test." The Contractor shall measure and record temperature, humidity, and other environmental parameters.

E. The Contractor shall schedule and coordinate the final acceptance tests. The Contractor shall provide necessary instruments, labor and materials required for tests. Provide equipment manufacturer's technical representative and qualified technicians.

F. The Contractor shall satisfy all items detailed in the final acceptance check-off list (punch list). The list shall be a complete representation of specified installation requirements. At the time of final acceptance punch list items shall be corrected until the system is found to be acceptable to the Owner and the Project Manager

END OF SECTION

SECTION 27 05 10

FIRESTOPPING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the products and execution requirements relating to Firestopping for Communications Systems.

C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

A. Provide product data from manufacturer’s specifications.

1.3 WORK INCLUDED

A. The work included under this Specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

B. The work shall include, but not be limited to the following:

1. Furnish and install all firestopping materials.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

A. Approved Firestopping Manufacturer(s)

1. Flamestopper Thru-Wall Fitting - Wiremold Company (Firestop Devices)
2. Unique Firestop Products (Firestop Devices)
3. STI Firestop Products (Firestop Devices, Putties, Caulks, Sealants, etc.)
4. Hilti (Putties, Caulks, Sealants, etc.)

2.2 TYPES OF PRODUCTS

A. Sealants

1. Intumescent Firestop Sealants and Caulks
2. Latex Firestop Sealant

3. Acrylic Water-Based Sealant
4. Silicone Firestop Sealants and Caulks
5. Firestop Putty
6. Firestop Collars
7. Wrap Strips
8. 2-Part Silicone Firestop Foam
9. Firestop Mortar
10. Firestop Pillows
11. Elastomeric Spray
12. Accessories:
13. Forming/Damming Materials: Mineral fiberboard or other type as per manufacturer recommendation

B. Firestop Devices

1. Thru-Wall Fitting (Flamestopper by Wiremold)
   a. The firestop device box shall be constructed of 16 gage G90 steel.
   b. The firestop device intumescent block shall be constructed of a graphite base material with expansion starting at 375°F and an unrestrained expansion between 6 to 12 times. The intumescent block shall be held securely by the box in order to prevent tampering and damage during installation.
   c. The firestop device shall have doors which can be adjusted to prevent materials from penetrating the device if the device is empty or completely full. The doors shall be constructed of 16 gage G90 steel with No. 10-32 screws use to adjust opening size.
   d. The firestop device shall be available for 2" and 4" trade size EMT conduit.
   e. The firestop device shall be available in safety yellow powder coat, custom colors and an unpainted galvanized finish.

2. Threaded Firestop Device (Unique Firestop Products)
   a. Threaded steel sleeve device incorporating flat washers secured by threaded device shall be installed around cables. The device shall be available in 1, 2 and 4-inch sizes. Maximum diameter of the wall penetration for 1, 2 and 4-inch sizes shall be 1-1/4, 2-7/16 and 4-1/2 inches respectively.

3. Smooth Firestop Device (Unique Firestop Products)
   a. Smooth steel sleeve device incorporating flat washers secured by sliding compression couplers. The device shall be available in 1, 2 and 4-inch sizes. Maximum diameter of the wall penetration for 1, 2 and 4-inch sizes shall be 1-1/4, 2-7/16 and 4-1/2 inches respectively.

4. Split-Sleeve Firestop Device (Unique Firestop Products)
   a. Threaded steel sleeve halves incorporating split couplings and slotted washers to fit the specific diameter of the opening. The device shall be available in 1, 2 and 4-inch sizes. Maximum diameter of the wall penetration for 1, 2 and 4-inch sizes shall be 1-1/4, 2-7/16 and 4-1/2 inches respectively.

5. Fire Rated Cable Pathway (STI EZ-PATH)
   a. Fire rated cable pathway device modules shall be comprised of steel raceway with intumescent foam pads allowing 0-100 percent cable fill.

2.3 UL CLASSIFICATION

A. Thru-Wall Fitting - The firestop device for use in through-penetration firestop systems shall have been examined and tested by Underwriters Laboratories Inc. to UL1479 (ASTM E 814) and bear the U.S. and Canadian UL Classification Mark.

B. Threaded, Smooth and Split-Sleeve Firestop Devices - Firestopping sealants and devices shall be used together as a firestop system. All firestop systems shall bear a UL Classification system number. UL Classification system numbers are as follows:

1. Threaded Firestop System
   a. Block Wall - W-J-3049
   b. Dry Wall - W-L-3138

2. Threaded Firestop System (Vertical)
   a. Slab - F-A-3010

3. Smooth Firestop System
   a. Block Wall - W-J-3048
   b. Dry Wall - W-L-3137

4. Split-Sleeve Firestop System
   a. Block Wall - W-J-3047
   b. Dry Wall - W-L-3136

2.4 FIRESTOPPING SYSTEMS

A. Thru-Wall Fitting Firestop System:

1. The device shall be classified for use in one-, two-, three, and four-hour rated gypsum, concrete and block walls and provide a maximum L rating of six cfm. The devices shall also been tested by Underwriters Laboratories Inc. to UL2043 and determined to be suitable for use in air handling spaces.

B. Threaded, Smooth and Split-Sleeve Firestop Systems:

1. Shall conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted test agencies per ASTM E814 or UL 1479 fire tests in a configuration that is representative of field conditions.
2. The F rating must be a minimum of one (1) hour but not less than the fire resistance rating of the assembly being penetrated. T rating when required by code authority shall be based on measurement of the temperature rise on penetrating item(s). The fire test shall be conducted with a minimum positive pressure differential of 0.01 inches of water column.
3. For joints, must be tested to UL 2079 with movement capabilities equal to those of the anticipated conditions.

C. Firestopping materials and systems must be capable of closing or filling through-openings created by 1) the burning or melting of combustible pipes, cable jacketing, or pipe insulation materials, or 2) deflection of sheet metal due to thermal expansion (electrical & mechanical duct work).

D. Firestopping material shall be asbestos and lead free and shall not incorporate nor require the use of hazardous solvents.

E. Firestopping sealants must be flexible, allowing for normal pipe movement.

F. Firestopping materials shall not shrink upon drying as evidenced by cracking or pulling back from contact surfaces.

G. Firestopping materials shall be moisture resistant, and may not dissolve in water after curing.

PART 3 - EXECUTION

3.1 CONDITIONS REQUIRING FIRESTOPPING

A. General

1. Provide firestopping for conditions specified whether or not firestopping is indicated, and if indicated, whether such material is designed as insulation, safing, or otherwise.

B. Through-Penetrations

1. Firestopping shall be installed in all open penetrations and in the annular space in all penetrations in any bearing or non-bearing fire-rated barrier.

C. Membrane-Penetrations

1. Where required by code, all membrane-penetrations in rated walls shall be protected with firestopping products that meet the requirements of third party time/temperature testing.

D. Construction Joints/Gaps

1. Firestopping shall be provided between the edges of floor slabs and exterior walls, between the tops of walls and the underside of floors, in the control joint in masonry walls and floors and in expansion joints.

E. Smoke-Stopping

1. As required by the other sections, smoke-stops shall be provided for through-penetrations, membrane-penetrations, and construction gaps with a material approved and tested for such application.

3.2 EXAMINATION

A. Examine the areas and conditions where firestops are to be installed and notify the Architect of conditions detrimental to the proper and timely completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.

B. Verify that environmental conditions are safe and suitable for installation of firestop products.

C. Verify that all pipes, conduit, cable, and other items that penetrate fire-rated construction have been permanently installed prior to installation of firestops.

3.3 INSTALLATION

A. General

1. Installation of firestops shall be performed by an applicator/installer qualified and trained by the manufacturer. Installation shall be performed in strict accordance with manufacturer's detailed installation procedures.
2. Apply firestops in accordance with fire test reports, fire resistance requirements, acceptable sample installations, and manufacturer's recommendations.
3. Unless specified and approved, all insulation used in conjunction with through-penetrants shall remain intact and undamaged and may not be removed.
4. Seal holes and penetrations to ensure an effective smoke seal.
5. In areas of high traffic, protect firestopping materials from damage. If the opening is large, install firestopping materials capable of supporting the weight of a human.
6. Insulation types specified in other sections shall not be installed in lieu of firestopping material specified herein.
7. All combustible penetrants (e.g. non-metallic pipes or insulated metallic pipes) shall be firestopped using products and systems tested in a configuration representative of the field condition.

B. Dam Construction

1. When required to properly contain firestopping materials within openings, damming or packing materials may be utilized. Combustible damming material must be removed after appropriate curing. Noncombustible damming materials may be left as a permanent component of the firestop system.

3.4 FIELD QUALITY CONTROL

A. Prepare and install firestopping systems in accordance with manufacturer's printed instructions and recommendations.

B. Follow safety procedures recommended in the Material Safety Data Sheets.

C. Finish surfaces of firestopping that are to remain exposed in the completed work to a uniform and level condition.

D. All areas of work must be accessible until inspection by the applicable Code Authorities.

E. Correct unacceptable firestops and provide additional inspection to verify compliance with this Specification.

3.5 CLEANING

A. Remove spilled and excess materials adjacent to firestopping without damaging adjacent surfaces.

B. Leave finished work in a neat and clean condition with no evidence of spill-overs or damage to adjacent surfaces.

3.6 IDENTIFICATION

A. Refer to Section 27 05 53 - Identification for Communications Systems for labeling details.

END OF SECTION

SECTION 27 05 26

GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the products and execution requirements relating to Grounding and Bonding for Communications Systems.

C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

A. Provide product data from manufacturer's specifications.

1.3 WORK INCLUDED

A. The work included under this Specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

B. The work shall include, but not be limited to the following:

1. Furnish and install all grounding conductors.
2. Furnish and install all grounding lugs and hardware.
3. Furnish and install all grounding busbars.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

A. Equipment Grounding Conductor Manufacturer(s)

1. Southwire
2. Or Approved Equal

B. Grounding Lug Manufacturer(s)

1. Burndy
2. Thomas & Betts
3. Or Approved Equal

C. Grounding Busbar Manufacturer(s)

1. Chatsworth Products, Inc.
2. Middle Atlantic
3. B-Line
4. Or Approved Equal

2.2 GROUNDING CONDUCTORS

A. Grounding Conductor

1. Construction shall be Type THHN copper conductors, insulated with heat and moisture resistant PVC over which a UL Listed jacket is applied.
2. Jacket color shall be green or black. Black jacketed cable shall be identified at each termination point with a wrap of green tape.

2.3 GROUNDING LUGS

A. Grounding Lugs and Hardware

1. Grounding lugs shall be 2-hole and installed with a crimper that when properly executed the die of the crimper impresses the die # on the lug base. All lugs shall be sleeved with clear heat-shrink to allow for inspection of the crimp. Silicon bronze or stainless steel bolts and washers shall be used to install lugs to equipment. Exothermic welding is also allowed.

2.4 GROUNDING BUSBARS

A. Grounding Busbar

1. The grounding busbar shall be made of 1/4" thick solid copper.
2. The grounding busbar shall be installed with minimum clearance, 1" offsets and 1-1/2" insulators.
3. The grounding busbar shall accommodate 2-hole compression lugs.
4. The grounding busbar shall meet or exceed ANSI/TIA-607-B requirements.

PART 3 - EXECUTION

3.1 GROUNDING

A. The facility shall be equipped with a Communications Bonding Backbone (TBB). This backbone shall be used to ground all communications cable shields, equipment, racks, cabinets, raceways, and other associated hardware that has the potential to act as a current carrying conductor. The TBB shall be installed independent of the building’s electrical and building ground and shall be designed in accordance with the recommendations contained in the ANSI/TIA-607-B Telecommunications Bonding and Ground Standard.

B. The main entrance facility/equipment room in each building shall be equipped with a telecommunications main grounding busbar (TMGB). Each telecommunications room (TR) shall be provided with a telecommunications ground busbar (TGB). The TMGB shall be connected to the building electrical entrance grounding facility.

C. All racks, metallic backboards, cable sheaths, metallic strength members, splice cases, cable trays, etc. entering or residing in the MC/IC/TC shall be grounded to the respective TGB or TMGB using a minimum #6 AWG stranded copper bonding conductor and compression lugs.

D. All wires used for communications grounding purposes shall be identified with a green insulation. Non-insulated wires shall be identified at each termination point with a wrap or green tape. All cables and busbars shall be identified and labeled in accordance with the ANSI/TIA-606-A.

E. See Section 27 05 43 - Underground Ducts and Raceways for Communications Systems for underground duct and raceway systems ground requirements.

3.2 IDENTIFICATION

A. Refer to Section 27 05 53 - Identification for Communications Systems for labeling details.

END OF SECTION

SECTION 27 05 28

PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the products and execution requirements relating to Pathways for Communications Systems.

C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

A. Provide product data from manufacturer's specifications.

1.3 WORK INCLUDED

A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

B. The work shall include, but not be limited to the following:

1. Furnish and install complete conduit system.
2. Furnish and install all communications outlet boxes.
3. Furnish and install all pull boxes.
4. Furnish and install all cable hangers.
5. Furnish and install all tie wraps/Velcro straps.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

A. Rigid/Intermediate Conduit Manufacturer(s)

1. Allied
2. Triangle
3. Wheatland
4. Youngstown

B. Non-Metallic (PVC) Manufacturer(s)

1. Carlon
2. Georgia Pipe Company

3. Or Approved Equal

C. Electrical Metallic Tubing (EMT) Manufacturer(s)

1. Allied
2. Triangle
3. Wheatland
4. Youngstown

D. Electrical Non-Metallic Tubing (ENT) Manufacturer(s)

1. Carlon
2. Or Approved Equal

E. EMT Fittings Manufacturer(s)

1. Thomas & Betts
2. Steel City
3. Or Approved Equal

F. ENT Fittings Manufacturer(s)

1. Carlon
2. Or Approved Equal

A. Innerduct/Inner-Conduit Channel Manufacturer(s)

3. Carlon
4. Endot Industries
5. MaxCell
6. Petroflex
7. Eastern

G. Metallic Communications Outlet Box Manufacturer(s)

1. Steel City
2. Raco
3. Or Approved Equal

H. Non-Metallic Communications Outlet Box Manufacturer(s)

1. Thomas & Betts
2. Carlon
3. Or Approved Equal

I. Pull Box Manufacturer(s)

1. Hoffman
2. OZ Gedney
3. Quazite
4. Or Approved Equal

J. Approved Cable Hanger Manufacturer(s)

1. MonoSystems – The Hook Series
2. Erico Products – Caddy Series
3. B-Line
4. Or Approved Equal

K. Approved Tie Wrap/Velcro Strap Manufacturer(s)

1. Thomas & Betts
2. Panduit
3. Or Approved Equal

2.2 CONDUIT

A. Rigid and Intermediate Conduit

1. Rigid conduit, intermediate conduit, couplings, locknuts, bushings, elbows and connectors shall be standard thread. All materials shall be steel. Set screw or non-threaded fittings are not permitted.

B. Non-Metallic (PVC) Conduit

1. Non-metallic conduit shall be heavy wall, Schedule 40 PVC.
2. Couplings and connectors for non-metallic conduit shall be of the same material and be the product of the same manufacturer of the conduit furnished.

C. Electrical Metallic Tubing (EMT)

1. Electrical metallic tubing (EMT), couplings and connectors shall be steel. Malleable iron, pressure-cast or die-cast fittings are not permitted.
2. Fittings for 2" EMT and smaller shall be steel set screw type, except where otherwise noted. Fittings for 2.5" and larger shall be steel set screw type with two (2) screws for connectors and four (4) screws for couplings. All connectors shall be insulated throat type.

D. Electrical Non-Metallic Tubing (ENT)

1. ENT shall be a pliable, non-metallic raceway manufactured of the same PVC material used for rigid non-metallic conduit.
2. Fittings and outlet boxes shall be designed for use with ENT and listed by Underwriters Laboratories.

E. Conduit Support

1. Individual conduit hangers shall be galvanized spring steel specifically designed for the purpose and sized appropriately for the conduit type and diameter. Support individual conduits 1-1/2 inch and smaller with 1/4 inch threaded steel rods and use 3/8 inch rods for 2 inch and larger.
2. Conduit support channels shall be 14 gauge galvanized (or equivalent treatment) channel sized for the amount of conduit to be supported. Channel suspension shall be 3/8" threaded steel rods. Attach suspension rods to structure with swivel type connectors. Conduit straps shall be spring steel type compatible with channel.
3. Conduit straps shall be single hole cast metal type or two hole galvanized metal type. Conduit clamps shall be spring steel type for use with exposed structural steel.

F. Innerduct/Inner-Conduit Channel

1. Innerduct shall be corrugated plastic equipped with pull-string or mule tape.
2. Inner-conduit channel (MaxCell) shall be 3-channel with each channel equipped with mule tape.
3. See Drawings for innerduct/inner-conduit channel (MaxCell) details.

2.3 METALLIC COMMUNICATIONS OUTLET BOXES

A. Metallic outlet boxes and device covers shall be galvanized steel not less than 1/16" thick.

B. The dimensions of the metallic outlet box shall be 4" x 4" square with a minimum depth of 2-1/8".

C. Metallic outlet boxes shall be equipped with single device covers (or two-device covers where needed). Where installed in plaster, gypsum board, etc., covers shall be raised to compensate for the thickness of the wall finish.

D. Where metallic outlet boxes are to be empty for future use, blank coverplates shall be used.

2.4 NON-METALLIC COMMUNICATIONS OUTLET BOXES

A. The non-metallic outlet box shall be thermoplastic and be rated according to the space it occupies.

B. The dimensions of the non-metallic outlet box shall be approximately 4" x 4" square with a minimum depth of 2-1/8".

C. Non-metallic outlet boxes shall be equipped with single device covers. Covers shall be raised to compensate for the thickness of the wall finish.

D. Where non-metallic outlet boxes are to be empty for future use, blank faceplates shall be used.

2.5 PULL BOXES

A. Pull boxes shall be constructed of galvanized steel with flat, removable covers fastened with plated steel screws.

B. Pull boxes shall be equipped with keyhole screw slots in the cover to permit removal of the cover without extracting the screws.

C. Pull boxes shall have provisions for grounding.

2.6 CABLE HANGERS

A. J-Hooks

1. J-hooks shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables. J-hook shall be cULus Listed.
2. J-hooks shall have flared edges to prevent damage while installing cables.
3. J-hooks sized 1-5/16" and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap shall be removable and reusable and be suitable for use in air handling spaces.

B. Adjustable Non-Continuous Cable Support Sling

1. Constructed from steel and woven laminate; sling length can be adjusted to hold up to 425 4-pair balanced twisted pair cables; rated for indoor use in non-corrosive environments. Rated to support Category 5 and higher cable, or optical fiber cable. Cable support sling shall be cULus Listed.
2. Adjustable non-continuous cable support sling shall have a static load limit of 100 lbs.
3. Adjustable non-continuous cable support sling shall be suitable for use in air handling spaces.

2.7 TIE WRAPS AND VELCRO STRAPS

A. Tie Wraps and Velcro Straps

1. Cables shall be fastened to support structures with tie wraps/Velcro straps.
2. Tie wraps/Velcro straps installed in air handling spaces must be plenum rated.
   a. Non-plenum Tie Wrap color shall be black.
   b. Plenum Tie Wrap color shall be red.
   c. Non-plenum Velcro strap color shall be black.
   d. Plenum Velcro strap color shall be red.

PART 3 - EXECUTION

3.1 PENETRATIONS

A. Holes through concrete and masonry in new and existing structures shall be cut with a diamond core drill or concrete saw upon approval of the structural engineer of record for the base of building. Pneumatic hammer, impact electric, hand or manual hammer type drills shall not be allowed, except where permitted by the Project Manager as required by limited working space. X-ray all floor penetrations accordingly.

B. Holes shall be located so as not to affect structural sections such as ribs or beams.

C. Holes shall be laid out in advance. The Project Manager shall be advised prior to drilling through structural sections, for determination of proper layout.

D. Structural Penetrations: Where conduits, wireways and other raceways pass through fire partitions, fire walls or walls and floors provide a code compliant effective barrier against the spread of fire, smoke and gases.

E. All penetrations where conduit is not used shall be sleeved.

F. No gaps or rough edges shall be allowed between wall and conduit/sleeve.

3.2 CONDUIT SYSTEM

A. Conceal all conduits, except in unfinished spaces such as equipment rooms or as indicated by symbol on the Drawings.

B. Leave all empty conduits with a 200 pound test nylon cord pull line.

C. Flattened, dented, or deformed conduits are not permitted and shall be removed and replaced.

D. Fasten conduit support device to structure with wood screws on wood, toggle bolts on hollow masonry, anchors as specified on solid masonry or concrete, and machine bolts, clamps, or spring steel clips, on steel.

E. Install conduit with wiring, including homeruns as indicated on the Drawings. Any change resulting in a savings in labor or materials is to be made only in accordance with a contract change. Deviations shall be made only where necessary to avoid interferences and when approved by Engineer by written authorization.

F. Conduit shall be run parallel or at right angles to existing walls, ceilings, and structural members.

G. Attach backbone conduits larger than one-inch trade diameter to or from structure on intervals not exceeding twelve feet with conduit beam clamps, one-hole conduit straps or trapeze type support.

H. Where conduits must pass through structural members obtain approval of Architect.

I. Install all conduits or sleeves penetrating or routed within rated firewalls or fire floors to maintain fire rating of wall or floor. Conduit shall not be installed in rated floors or walls if it compromises or violates the fire rating of floor or wall. Refer to architectural documents.

J. Provide expansion and deflection coupling where conduit passes over a building expansion joint.

K. Service entrance conduits and feeder conduits in direct contact with earth shall be schedule 40, heavy wall PVC. All service entrance conduit elbows shall be galvanized rigid steel. Service entrance conduits installed exposed or concealed in walls or above ceilings shall be galvanized rigid steel (G.R.S.) or intermediate metal conduit (IMC). Service entrance conduits shall be installed "outside" of the building as defined by the N.E.C. Provide concrete encasement where required or as indicated on Drawings.

L. All other conduit, unless specified herein, shall be electrical metallic tubing (EMT) or electrical non-metallic tubing (ENT). PVC conduit is not allowed in exposed or concealed areas, but only within concrete.

M. Conduit Installations Within Slab/Floor

1. Conduit shall be run following the most direct route between points.
2. Conduit shall not be installed in concrete where the outside diameter is larger than 1/3 of the slab thickness.
3. Conduits shall not be installed within shear walls unless specifically indicated on the Drawings. Conduit shall not be run directly below and parallel with load bearing walls.
4. Protect each metallic conduit installed in concrete slab or conduits 1-1/2 inch and smaller passing through a concrete slab against corrosion where conduit enters and leaves concrete by wrapping conduit with vinyl all-weather electrical tape.
5. Protect all conduits entering and leaving concrete floor slabs from physical damage during construction.
6. Provide expansion fittings in all conduits where length or run exceeds 200 feet or where conduits pass through building expansion joints.
7. Install all conduits penetrating or routed within rated fire floors to maintain the fire rating of the floor. Conduit shall not be installed in rated floors or walls if it compromises or violates the fire rating of floor or wall. Refer to architectural documents.
8. Conduits installed within concrete floor slabs which are in direct contact with grade or which penetrate the building roof shall be galvanized rigid steel (G.R.S.), intermediate metal conduit (I.M.C.) or Schedule 40, heavy wall PVC.

N. Communications cables shall not occupy conduits with power cables.

O. Metallic conduits shall be grounded in accordance with ANSI/TIA-607-B.

P. Conduit runs shall not have more than two (2) 90-degree bends between pull points.

Q. Communications conduit system shall contain no condulets (also known as an LB).

R. Rigid metal conduit (RMC) or intermediate metal conduit (IMC) shall be used for entrance conduits that exceed 50 feet into the building.

S. Horizontal Conduits

1. Support horizontal conduits at intervals not exceeding ten feet and within three feet of each outlet, junction box, backboard, enclosure or cabinet. Support conduits from structural steel members with spring steel type or beam conduit clamps and to non-metallic structural members with one-hole conduit straps. For exposed conduits and where conduits must be suspended below structure, single conduit runs shall be supported from structure by hanger rod and conduit clamp assembly, and multiple conduits shall be supported by trapeze type support suspended from structure. Do not attach conduits to ceiling suspension system channels or suspension wires.
2. For runs that total more than 100 feet in length, insert pull boxes so that no segment between boxes exceeds the 100 feet limit.
3. Each horizontal home-run conduit can serve from one (1) to three (3) outlet boxes. For one (1) outlet box, a 3/4" conduit shall be used, minimum. For two (2) outlet boxes, a 1" conduit shall be used, minimum. For three (3) outlet boxes, a 1-1/4" conduit shall be used, minimum.

3.3 COMMUNICATIONS OUTLET BOXES

A. Exact locations of the outlet boxes shall be coordinated with the electrical contractor and other trades.

B. The approximate locations of the outlets are indicated on the Drawings. The exact locations shall be determined at the building. The right is reserved to change, without additional cost, the exact location of any outlet, a maximum of 10' before it is permanently installed.

C. Orientation of outlet boxes (horizontal or vertical) shall be as indicated on the architectural elevations.

D. Install all outlet boxes in finished areas flush with the wall. Maintain 1/4" or less space between outlet box front and finished wall surface.

E. Outlet boxes shall be firmly anchored in place and shall not depend on the coverplate to hold it secure to the wall.

F. Outlet boxes installed back-to-back in fire-rated walls shall be separated horizontally by a minimum of 24".

3.4 PULL BOXES

A. Pull boxes shall be secured, independent of the conduit entries into the box. Pull boxes shall be secured to the building structure. In ceiling applications, pull boxes shall not be supported with ceiling wires.

B. Conduits entering pull boxes shall connect to pull boxes using die-cast zinc connectors.

C. Pull boxes shall be free from burrs, dirt and debris.

D. Pull boxes shall be installed in accordance with ANSI/TIA-569-B.

E. Pull boxes shall be grounded in accordance with ANSI/TIA-607-B.

3.5 CABLE HANGERS

A. Installation and configuration shall conform to the requirements of ANSI/TIA-568-C.0, ANSI/TIA-568-C.1 & ANSI/TIA-569-B, NFPA 70 (National Electrical Code), applicable local codes, and to the manufacturer's installation instructions.

B. Install cables using techniques, practices, and methods that are consistent with Category 5e or higher requirements and that supports Category 5e or higher performance of completed and linked signal paths, end to end.

C. Install cables without damaging conductors, shield, or jacket.

D. Do not bend cables, in handling or in installing, to smaller radii than minimums recommended by manufacturer.

E. Pull cables without exceeding cable manufacturer's recommended pulling tensions. Use pulling means that will not damage media.

F. Do not exceed load ratings specified by manufacturer.

G. Adjustable non-continuous support sling shall have a static load limit of 100 lbs.

H. To avoid electromagnetic interference (EMI), pathways shall provide minimum clearances of four feet from motors or transformers, one foot from conduit and cables used for electrical power distribution, and five inches from fluorescent lighting. Pathways shall cross perpendicular to fluorescent lighting and electrical power cables or conduits.

3.6 TIE WRAPS AND VELCRO STRAPS

A. Tie wraps/Velcro straps shall be installed around cables at intervals of 12" minimum.

B. Do not over-cinch cables.

3.7 IDENTIFICATION

A. Refer to Section 27 05 53 - Identification for Communications Systems for labeling details.

END OF SECTION

SECTION 27 05 43

UNDERGROUND DUCTS AND RACEWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the products and execution requirements relating to Underground Ducts and Raceways for Communications Systems.

C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

A. Provide product data from manufacturer's specifications.

1.3 WORK INCLUDED

A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

B. The work shall include, but not be limited to the following:

1. Furnish and install complete conduit system.
2. Furnish and install all maintenance holes/handholes.
3. Furnish and install all conduit plugs/caps.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

A. Rigid/Intermediate Conduit Manufacturer(s)

1. Allied
2. Triangle
3. Wheatland
4. Youngstown

B. PVC/HDPE Conduit Manufacturer(s)

1. Carlon
2. Georgia Pipe Company
3. FiberTel

4. Or Approved Equal

C. Innerduct/Inner-Conduit Channel Manufacturer(s)

1. Carlon
2. Endot Industries
3. MaxCell
4. Petroflex

D. Marker Tape Manufacturer(s)

1. William Frick & Associates
2. Or Approved Equal

E. Approved Maintenance Hole/Handhole Manufacturer(s)

1. Quazite
2. Old Castle
3. Pencell
4. Or Approved Equal

F. Approved Conduit Plug/Cap Manufacturer(s)

1. Jack Moon
2. Or Approved Equal

2.2 CONDUIT SYSTEM

A. PVC conduit for concrete encasement shall be Type DB, UL Labeled for 90 degrees C cables. Fittings shall be Type DB, solvent type, and from the same manufacturer as the conduit.

B. Concrete shall have a minimum strength of 2,500 psi at 28 days.

C. PVC conduit for direct burial shall be Schedule 40, UL Labeled for 90 degrees C cables. Fittings shall be Schedule 40, solvent type, and from the same manufacturer as the conduit.

D. Rigid and Intermediate Conduit

1. Rigid conduit, intermediate conduit, couplings, locknuts, bushings, elbows and connectors shall be standard thread. All materials shall be steel. Set screw or non-threaded fittings are not permitted.
2. Galvanized rigid steel conduit shall be hot dipped galvanized inside and outside, in 10 foot lengths and threaded on both ends. Fittings and bushings shall be threaded, cast or malleable iron, and hot dipped galvanized inside and outside.

E. Non-Metallic Conduit

1. Non-metallic conduit shall be heavy wall, Schedule 40 PVC/HDPE.
2. Couplings and connectors for non-metallic conduit shall be of the same material and be the product of the same manufacturer of the conduit furnished.

F. Conduit Support

1. Conduit straps shall be single-hole cast metal type or two hole galvanized metal type. Conduit clamps shall be spring steel type for use with exposed structural steel.

G. Innerduct/Inner-Conduit Channel

1. Innerduct shall be non-corrugated PVC equipped with mule tape.
2. Inner-conduit channel (MaxCell) shall be 3-channel with each channel equipped with mule tape.
3. See Drawings for innerduct/inner-conduit channel (MaxCell) details.

H. Marker Tape

1. Marker tape shall be detectable, orange for communications, and labeled to indicate the type of circuit buried below.

2.3 MAINTENANCE HOLES/HANDHOLES

A. Maintenance Holes

1. Maintenance holes shall be pre-cast or cast in place concrete with a strength of 3,500 psi at 28 days, and steel reinforced.
2. Maintenance holes shall include a cast iron frame with cover, a hot dipped galvanized steel ladder, and hot dipped galvanized pulling eyes embedded in the concrete opposite each duct entrance and in the floor beneath the cover.
3. Maintenance holes shall be equipped with grounding busbar.
4. Maintenance holes shall be equipped with racking for cable storage.
5. Ground splices and connections at maintenance holes shall be exothermic welds, copper or bronze compression ground fittings, or bolted compression ring lugs.
6. The cover for maintenance holes shall have the lettering, “COMMUNICATIONS.”

B. Handholes

1. Handholes shall be non-conductive and shall not require grounding for safety. Handholes shall be unaffected by freeze/thaw and resistant to sunlight and chemicals. Handholes shall be pre-cast polymer concrete, heavy duty rated and bottomless.
2. Handholes shall be equipped with racking for cable storage.
3. Handholes shall have the word “COMMUNICATIONS” molded in the cover by the manufacturer. The cover shall be attached with penta-head stainless steel bolts.
4. Handholes shall be able to withstand 10,000 lbs minimum.
5. See Drawings for handhole dimensions and locations.

2.4 CONDUIT PLUGS/CAPS

A. Conduit Plugs/Caps

1. Conduit plugs shall provide a watertight seal at expose ends of conduits.
2. Conduit plugs shall be conduit size specific.
3. Triplex and Quadplex duct plugs shall provide a watertight seal between the conduit and innerduct(s).
4. Simplex duct plugs shall provide a watertight seal between the innerduct and the cable that occupies it.
5. TDUX inflatable bladders shall be used to seal conduits equipped with MaxCell.

PART 3 - EXECUTION

3.1 CONDUIT SYSTEM

A. Excavation and Backfill

1. Contractor shall call underground utilities locator company before digging.
2. Barricades shall be provided around open holes and trenches. Temporary bridges shall be provided over trenches cut through major sidewalk routes. Major sidewalk routes shall not be closed to pedestrian traffic.
3. Barriers shall be provided to protect landscaping adjacent to the excavation area.
4. When rocks, concrete or other debris are encountered during excavation, remove completely.
5. Where sidewalk sections must be removed for installation of underground ducts, remove the sidewalk sections completely from joint to joint.
6. Where asphalt must be removed for installation of underground ducts, saw cut the asphalt in two, straight, parallel lines.
7. Backfill excavations in 6-inch layers and mechanically compact to 98 percent compaction.
8. Excavated materials may be used as backfill only if the backfill is sand or clean dirt that is free of rocks and debris over 3/4" in diameter.
9. In landscaped areas, backfill and mechanically compact to a depth of 6 inches below grade.
10. Backfill the last 6 inches with clean topsoil. Reseed lawn areas.
11. Restore concrete sidewalks and asphalt.
12. The Contractor shall perform all excavation to install the electrical work herein specified and as indicated on Drawings. During excavation, material for backfilling shall be piled back from the banks of the trench to avoid overloading and to prevent slides and cave-ins. All excavated materials not to be used for backfill shall be removed and disposed of by the Contractor. Grading shall be done to prevent surface water from flowing into trenches and others excavation and any water accumulating therein shall be removed by pumping. All excavation shall be made by open cut.
13. The bottom of the trenches shall be graded to provide uniform bearing and support for conduits, cables, or duct bank on undisturbed soil at every point along its entire length. Overdepths shall be backfilled with loose, granular, moist earth, tamped. Remove unstable soil that is not capable of supporting equipment or installation and replace with specified material for a minimum of 12" below invert of equipment or installation.
14. The trenches shall be backfilled with the excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand and gravel or soft shale, free from large clods of earth and stones, deposited in 6" layers and rammed until the installation has a cover of not less than the adjacent ground but not greater than 2" above existing ground. The backfilling shall be carried on simultaneously on both sides of the trench so that injurious pressures do not occur. The compaction of the filled trench shall be at least equal to 95% of the maximum density as determined by the Standard Proctor Test. Settling the backfill with water will not be permitted. Reopen any trenches not meeting compaction requirements or where settlement occurs, refill, compact, and restore the surface to the grade and compaction indicated, mounded over and smoothed off.

B. Duct Banks

1. Duct banks shall be sloped downward toward maintenance holes/handholes and away from buildings a minimum of 6 inches per 100 feet. Duct banks shall not route water from maintenance holes handholes into buildings. Duct banks shall not contain traps between maintenance holes/handholes where water may accumulate.
2. Directional changes in duct banks shall be made with 20' minimum radius bends. Duct banks and direct buried ducts shall be supported on undisturbed soil or on piers extending down to undisturbed soil.

3. Where power and communications duct banks run in parallel, they shall be separated by a minimum of 12 inches.
4. Prior to concrete encasement, ducts, reinforcing steel and ground wires shall be secured with nonmetallic straps or cable ties to nonmetallic duct spacers at intervals not exceeding 8 feet. Duct spacers shall be sized for the ducts being held, and shall provide the minimum spacing between ducts required for concrete flow and by the NEC. Duct spacers shall be anchored to the ground using nonmetallic bands and stakes.
5. Duct banks shall have a minimum of 3 inches of concrete cover on all sides.
6. Where duct banks enter maintenance holes or buildings, they shall be constructed as integral to the wall.
7. Duct bank shall extend to the inside surfaces of the walls, and the duct bank reinforcing shall be integrated with the wall reinforcing.
8. Bell ends shall be provided on ducts where the ducts enter maintenance holes or buildings.
9. Direct buried ducts and fittings shall have bend radii greater than the minimum bend radii of the cables enclosed, and shall not be smaller than the radii of standard manufactured elbows.
10. Direct buried ducts shall be installed parallel to or at right angles to building lines and site features, and as close to curbs and sidewalks as possible to avoid interferences with future landscaping.
11. Where direct buried PVC ducts cannot be buried deep enough to meet the NEC minimum cover requirements, rigid steel conduits shall be installed instead, or a concrete cover shall be poured over the ducts.
12. An orange detectable marker tape (for communications) shall be buried in the backfill approximately 12 inches above duct banks or direct buried cables for the entire length of the duct run.
13. A flexible mandrel and a stiff bristled brush shall be pulled through the ducts to clean them prior to cable pulling.
14. Ducts shall be identified in the maintenance holes and at both ends.

C. Additional OSP Conduit Requirements

1. Leave all empty conduits with a 200-pound test nylon cord pull line.
2. Install a #14 AWG tracer wire in one conduit for the entire length of each duct run.
3. Flattened, dented, or deformed conduits are not permitted and shall be removed and replaced.
4. Install conduit, including homeruns as indicated on the Drawings. Any change resulting in a savings in labor or materials is to be made only in accordance with a contract change. Deviations shall be made only where necessary to avoid interferences and when approved by Engineer by written authorization.
5. Where conduits must pass through structural members obtain approval of Architect.
6. Install all conduits or sleeves penetrating or routed within rated firewalls or fire floors to maintain fire rating of wall or floor. Conduit shall not be installed in rated floors or walls if it compromises or violates the fire rating of floor or wall. Refer to architectural documents.
7. Provide expansion and deflection coupling where conduit passes over a building expansion joint.
8. Service entrance conduits and feeder conduits in direct contact with earth shall be schedule 40, heavy wall PVC/HDPE. All service entrance conduit elbows shall be galvanized rigid steel. Service entrance conduits installed exposed or concealed in walls or above ceilings shall be galvanized rigid steel (GRS) or intermediate metal conduit (IMC). Service entrance conduits shall be installed "outside" of the building as defined by the N.E.C. Provide concrete encasement where required or as indicated on Drawings.
9. Seal all conduits entering building to prevent entrance of moisture.
10. Conduit fittings shall be gland and ring compression type for all conduit exposed to outdoor environments.
11. Below Grade Conduit Installations
    a. Install top of conduits 24 inches minimum below finished grade and as indicated on Drawings.
    b. Install top of conduits 6 inches minimum below bottom of building slabs.

c. Where transition is made from below grade PVC installation to a metallic conduit system above grade or slab.

12. Communications cables shall not occupy conduits with power cables.
13. All metallic conduits shall be grounded in accordance with J-STD-607-A.
14. For runs that total more than 400 feet in length, insert handholes/maintenance holes so that no segment exceeds the 400 feet limit.
15. Conduit runs shall not have more than two (2) 90-degree bends between pull points.
16. Communication conduit system shall contain no condulets (also known as an LB).

3.2 MAINTENANCE HOLES/HANDHOLES

A. Maintenance holes/handholes shall be installed on a base of pea gravel at least 12 inches deep.

B. Tops of maintenance holes/handholes shall be level with the existing grade.

C. Ducts should enter as perpendicular to the wall surface as possible.

D. Maintenance holes shall be grounded with four 3/4 inch diameter by 8 foot long ground rods, one driven inside of the maintenance hole at each corner. Connect the ground rods and any duct bank ground conductors together with a No. 4/0 AWG bare, stranded copper ground wire loop. A No. 2 AWG bare stranded copper pigtail from the ground wire loop shall be used to ground the maintenance hole cover frame, ladder support bracket, any metallic concrete inserts and metallic cable racks, and the shields of any cables that are spliced in the maintenance hole.

3.3 CONDUIT PLUGS/CAPS

A. Protect conduits against dirt, plaster, and foreign debris with conduit plugs. Plugs shall remain in place until ready for use.

B. Simplex, triplex or quadplex duct plugs shall be installed in conduits to house and seal cables.

C. TDUX inflatable bladders shall be used to seal conduits equipped with MaxCell.

3.4 IDENTIFICATION

A. Refer to Section 27 05 53 - Identification for Communications Systems for labeling details.

END OF SECTION

SECTION 27 05 53

IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the equipment and execution requirements relating to Identification for Communications Systems.

C. Equipment specifications, general considerations, and guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 WORK INCLUDED

A. The work included under this Specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

B. The work shall include, but not be limited to the following:

1. Perform all labeling.

PART 2 - LABELING

2.1 LABELING REQUIREMENTS

A. Labeling shall be done in accordance with the recommendations made in the ANSI/TIA-606-A document, manufacturer's recommendations and best industry practices.

B. All spaces, pathways, outlets, cables, termination hardware, grounding system and equipment shall be labeled with machine-generated labels.

C. All labels shall be clear with black text.

D. All cables shall be labeled with machine generated, wrap around labels.

E. A total of three (3) labels per horizontal cable are required at the following intervals: 6" from outlet; 18" from outlet; 12" from termination block/patch panel.

F. Labeling scheme shall be alphanumeric.

PART 3 - NOT USED

END OF SECTION

SECTION 27 08 00

COMMISSIONING OF COMMUNICATIONS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the equipment and execution requirements relating to Commissioning of Communications.

C. Equipment specifications, general considerations, and guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 WORK INCLUDED

A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

B. The work shall include, but not be limited to the following:

1. Perform all copper cabling testing.
2. Perform all optical fiber cabling testing.
3. Perform all coaxial cabling testing.
4. Provide all documentation, as-builts, training and warranty.

PART 2 - TESTING

2.1 TESTING REQUIREMENTS

A. General

1. All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA-568-C.0 and/or ANSI/TIA-568-C.1. All conductors/strands of each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors/strands in all cables installed.

B. Copper Testing

1. All twisted-pair copper cable links shall be tested for continuity, pair reversals, shorts, opens and performance as indicated below. Additional testing is required to verify Category 6 performance. Horizontal balanced twisted pair cabling shall be tested using a level III test unit for Category 6 performance compliance.
2. Continuity - Each pair of each installed cable shall be tested using a test unit that shows opens, shorts, polarity and pair-reversals, crossed pairs and split pairs. The test shall be recorded as pass/fail

as indicated by the test unit and referenced to the appropriate cable identification number and circuit or pair number. Any faults in the wiring shall be corrected and the cable re-tested prior to final acceptance.

3. Length - Each installed cable link shall be tested for installed length using a TDR type device. The cables shall be tested from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length shall conform to the maximum distances set forth in the ANSI/TIA-568-C.2 Standard. Cable lengths shall be recorded, referencing the cable identification number and circuit or pair number. For multi-pair cables, the shortest pair length shall be recorded as the length for the cable.

C. Fiber Testing

1. All fiber testing shall be performed on all fibers in the completed end-to-end system. There shall be no splices unless clearly defined in the RFP and/or Drawings. These tests also include continuity checking of each fiber.
2. Multimode
   a. Test the optical fiber cable bi-directionally with an OTDR and uni-directionally with a power meter/light source. Fiber must be tested at both 850nm and 1300nm. Maximum attenuation dB/Km @ 850nm/1300nm shall be 3.5/1.5. Maximum attenuation per connector pair shall be .75 dB. Attenuation testing shall be performed with a stable launch condition using a one-meter or two-meter jumper, wrapped around a mandrel sized according to fiber type, to attach the light source to the cable plant. Fiber jumper shall be wrapped around mandrel no less than five (5) times. The jumper-mandrel assembly shall remain connected to the light source after calibration and the power meter moved to the far end using a new jumper to take measurements. Test set-up and performance shall be conducted in accordance with ANSI/TIA-568-C.3, and to the manufacturer's application guides.

3. Singlemode
   a. Test the optical fiber cable bi-directionally with an OTDR and uni-directionally with a power meter/light source. Fiber must be tested at both 1310nm and 1550nm. Maximum attenuation dB/Km @ 1310nm/1550nm shall be 0.5/0.5 for outside plant and 1.0/1.0 for inside plant. Maximum attenuation per connector pair shall be .75 dB. Attenuation testing shall be performed with a stable launch condition using one-meter or two-meter jumpers to attach the test equipment to the cable plant. The light source shall be left in place after calibration and the power meter moved to the far end to take measurements. Test set-up and performance shall be conducted in accordance with ANSI/TIA-568-C.3, and to the manufacturer's application guides.

4. Approved optical fiber test equipment manufacturers are as follows:
   a. Power Meters & Light Sources
      1) Optical Wavelength Laboratories (OWL)
      2) Noyes
      3) Photonix
      4) Fluke
      5) Agilent
   b. Optical Time Domain Reflectometers (OTDR)
      1) GN Nettest
      2) Agilent
      3) Fluke
      4) Anritsu
      5) Tektronix

D. Coaxial Testing

1. Sweep testing of each reel of coaxial cable shall be performed over the 5 MHz through 1 GHz range by the cable manufacturer for transmission and structural return loss and be so certified in writing by the cable manufacturer.
2. Verification testing with a verification field test instrument will determine shorts, continuity, termination location and length of cable.
3. Approved* testers are as follows:
   a. Fluke – CableIQ Series
   b. Test-Um – Validator Series
   *A level IIe, III or IV certification tester may be used in lieu of approved tester.

4. Signal strength measurement shall be performed with a field strength meter.
5. Signal level at each outlet will be +5 dBmv, + 3 dB.
6. Approved signal strength meters are as follows:
   a. Acterna – Stealth Series
   b. Acterna – MicroStealth Series
   c. Acterna – CLI Series
   d. Sadelco – DisplayMax Series
   e. Sadelco – DisplayMax Jr. Series
   f. Promax – Prolink Series

E. Test Results

1. Test documentation shall be provided on disk as part of the as-built package. The disk shall be clearly marked on the outside front cover with the words “Project Test Documentation,” the project name, and the date of completion (month and year). The results shall include a record of test frequencies, cable type, conductor pair (or strand) and cable (or outlet) I.D., measurement direction, reference setup, and crew member name(s). The test equipment name, manufacturer, model number, serial number, software version and last calibration date will also be provided at the end of the document. Unless the manufacturer specifies a more frequent calibration cycle, an annual calibration cycle is anticipated on all test equipment used for this installation. The test document shall detail the test method used and the specific settings of the equipment during the test as well as the software version being used in the field test equipment.
2. The field test equipment shall meet the requirements of ANSI/TIA-568-C.2 and/or ANSI/TIA-568-C.3.
3. Printouts generated for each cable by the wire (or fiber) test instrument shall be submitted as part of the documentation package. Alternately, the Contractor may furnish this information in electronic form (CD). These CDs shall contain the electronic equivalent of the test results as defined by the Specification and be of a format readable from Microsoft Word.
4. When repairs and re-tests are performed, the problem found and corrective action taken shall be noted, and both the failed and passed test data shall be documented.

PART 3 - DOCUMENTATION, AS-BUILTS, TRAINING AND RECORDS

3.1 DOCUMENTATION & AS-BUILTS

A. As-Built record documentation for communications work shall include:

1. Cable routing and identification
2. System function diagrams
3. Manufacturers' description literature for equipment
4. Connection and programming schedules as appropriate
5. Equipment material list including quantities

6. Spare parts list with quantities
7. Details not on original Contract Documents
8. Test results
9. Warranties
10. Release of liens

B. The Contractor shall provide and maintain at the site a set of prints on which shall be accurately shown the actual installation of all work under this section, indicating any variation from contract drawings, including changes in pathways, sizes, locations and dimensions. All changes shall be clearly and completely indicated as the work progresses.

C. Progress prints shall be available for inspection by the Owner or any of his representatives and may be used to determine the progress of communications infrastructure work.

D. At the completion of the work, prepare a new set of as-built drawings, of the work as actually noted on the marked-up prints, including the dimensioned location of all pathways.

E. Furnish as-built drawings and documentation to the Project Manager. As-built drawings shall be generated in AutoCAD 2006 or later. Submit as-built drawings electronically on CD and hard copy.

3.2 OPERATIONS AND MAINTENANCE MANUAL

A. After completion of the work, the Contractor shall furnish and deliver to the Engineer three (3) copies of a complete Operations & Maintenance Manual. A system wiring diagram shall be furnished for each separate system.

B. The manual shall be subdivided into separate sections with tab dividers to identify subsystems of the integrated system. Reference appropriate Specification sections.

C. Provide the following additional information for each electronic system. Information shall be edited for this project where applicable.

1. Operations manuals for components and for systems as a whole
2. Maintenance manuals for components and for system as a whole
3. Point-to-point diagrams, cabling diagrams, construction details and cabling labeling details
4. List of spare parts, materials and suppliers of components. Provide name, address and telephone number for each supplier.
5. Emergency instructions for operational and maintenance requirements
6. Delivery time frame for replacement of component parts from suppliers
7. Recommended inspection schedule and procedures for components and for system as a whole
8. List of spare parts, materials and suppliers of components. Provide name, address and telephone number for each supplier.
9. Complete “reviewed” shop drawings and product data for components and system as a whole
10. Troubleshooting procedures for each system and for each major system component

3.3 TRAINING

A. The Contractor shall be responsible for training of facility personnel. Training shall take place after occupancy and before acceptance and shall include programs for on-site operations and maintenance of technology and communications systems. Training shall be for not more than ten (10) people, shall be held

at the Owner's site and shall be of sufficient duration and depth to ensure that the trained personnel can operate the installed systems and can perform usual and customary maintenance actions.

3.4 WARRANTY

A. General

1. All equipment is to be new and warranted free of faulty workmanship and damage.
2. Replacement of defective equipment and materials and repair of faulty workmanship within 24 hours of notification, except emergency conditions (system failures), which must be placed back in service within eight (8) hours of notification, all at no cost to the Owner.
3. The minimum warranty provisions specified shall not diminish the terms of individual equipment manufacturer's warranties.

B. Voice & Data Structured Cabling

1. Manufacturer(s) shall provide a minimum 15-year warranty for components used in the installed Voice & Data Structured Cabling System. Defective and/or improperly installed products shall be replaced and/or correctly installed at no cost to the Owner.

C. Coaxial Cabling Infrastructure

1. Manufacturer(s) shall provide a minimum 1-year warranty for components used in the installed Coaxial Cabling Infrastructure. Defective and/or improperly installed products shall be replaced and/or correctly installed at no cost to the Owner.

D. Satellite Infrastructure

1. Manufacturer(s) shall provide a minimum 1-year warranty for components used in the installed Satellite Infrastructure. Defective and/or improperly installed products shall be replaced and/or correctly installed at no cost to the Owner.

E. Pathway & Support Infrastructure

1. Manufacturer(s) shall provide a minimum 1-year warranty for components used in the installed Pathway & Support Infrastructure. Defective and/or improperly installed products shall be replaced and/or correctly installed at no cost to the Owner.

END OF SECTION

SECTION 27 11 13

COMMUNICATIONS ENTRANCE PROTECTION

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the products and execution requirements relating to Communications Entrance Protection.

C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

A. Provide product data from manufacturer's specifications.

1.3 WORK INCLUDED

A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

B. The work shall include, but not be limited to the following:

1. Furnish and install all building entrance protector terminals.
2. Furnish and install all bonding shield connectors.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

A. Approved Building Entrance Protector Terminal Manufacturers

1. Circa
2. Marconi
3. Porta Systems

B. Approved Bonding Shield Connector Manufacturers

1. 3M
2. Or Approved Equal

2.2 BUILDING ENTRANCE PROTECTOR TERMINALS

A. Indoor Building Entrance Protector Terminal

1. The indoor building entrance protector terminal shall be equipped with 110-connector inputs and outputs and shall accommodate industry standard 5-pin protection modules.
2. The indoor building entrance protector terminal shall protect up to 100-pairs and shall be equipped with an internal fuse link.
3. The indoor building entrance protector terminal shall be wall or frame mountable, and able to be stacked for future expansion.
4. The indoor building entrance protector terminal shall be equipped with external ground connectors that accept 6-14 AWG ground wire.

B. Solid State Surge Protection Modules

1. The solid-state surge protector module shall be 5-pin and shall provide transient and power fault protection for standard telephone line applications.
2. The solid-state surge protector module shall be designed to provide a balanced configuration to protect against line-to-line metallic surges.
3. The solid-state surge protector module shall feature an external failsafe mechanism, which permanently grounds module under sustained high current conditions.
4. The solid-state surge protector module shall feature nanosecond response time and safe mode operation in adverse situations.
5. The solid-state surge protector module shall be UL & cUL Listed.

2.3 BONDING SHIELD CONNECTOR

A. Shield Connector

1. The purpose of the bonding shield connector is to make a stable, low resistant electrical connection between the shield of a communications cable and a ground conductor.
2. The bonding shield connector shall be tin-plated tempered brass.

PART 3 - EXECUTION

3.1 BUILDING ENTRANCE PROTECTOR TERMINALS

A. All copper circuits shall be provided with protection between each building with an entrance cable protector panel. All building-to-building circuits shall be routed through this protector. The protector shall be connected with a #6 AWG copper bonding conductor between the protector ground lug and the telecommunications room (TR) busbar.

B. Building entrance protector shall be installed in accordance with the recommendations contained in the ANSI/TIA-607-B Telecommunications Bonding and Ground Standard.

C. Building entrance protector panels shall be installed as per the requirements specified by the manufacturer's installation guidelines.

3.2 BONDING SHIELD CONNECTOR

A. Bonding shield connector shall be installed in accordance with the recommendations contained in the ANSI/TIA-607-B Standard.

B. Bonding shield connector shall be installed as per the requirements specified by the manufacturer's installation guidelines.

3.3 IDENTIFICATION

A. Refer to Section 27 05 53 - Identification for Communications Systems for labeling details.

END OF SECTION

SECTION 27 11 16

COMMUNICATIONS CABINETS, RACKS AND ENCLOSURES

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the products and execution requirements relating to Communications Cabinets, Racks and Enclosures.

C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

A. Provide product data from manufacturer's specifications.

1.3 WORK INCLUDED

A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all the required material whether specifically addressed in the Specification or not.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

A. Approved Equipment Rack/Cabinet Manufacturer(s)

1. Middle Atlantic
2. Chatsworth Products, Inc.
3. Eaton
4. Or Approved Equal

2.2 EQUIPMENT RACKS/CABINETS

A. Equipment Racks

1. The equipment rack shall be constructed of high strength, lightweight aluminum.
2. The vertical rails of the equipment rack shall be equipped with the EIA hole pattern.
3. 2-Post Rack shall be: 45U H x 19" W x 18" D, floor mounted.
4. 4-Post Rack shall be: 45U H x 19" W x 29" D, floor mounted.
5. Wall Mount Rack shall be: 21U H x 19" W x 18" D.
6. Rack color shall be black

B. Equipment Cabinets

1. The frame of the equipment cabinet shall be constructed of high strength steel.
2. Front and rear doors of the equipment cabinet shall be lockable.
3. The vertical rails of the equipment cabinet shall be equipped with the EIA hole pattern.
4. 42U Cabinet shall be: 80” H x 23.6" W x 31.5" D, floor mounted.
5. 45U Cabinet shall be: 85” H x 23.6" W x 39.4" D, floor mounted.
6. 19U Wall Mount Cabinet shall be: 36” H x 24" W x 18" D.
7. Cabinet color shall be black.

2.3 BACKBOARDS

A. Backboards shall be 3/4" void free plywood. Size of backboard shall be 4' x 8' unless noted differently on Drawings. Backboards shall be painted with two (2) coats of gray fire-retardant paint

PART 3 - EXECUTION

3.1 EQUIPMENT RACKS/CABINETS

A. Equipment racks shall be securely attached to the concrete floor using minimum 3/8" hardware or as required by local codes.

B. Equipment cabinets shall be installed as per the requirements specified by the manufacturer's installation guidelines.

C. Equipment racks/cabinets shall be placed with a minimum of 40-inch clearance from the walls from the front and rear of the rack or as indicated on Drawings.

D. All equipment racks/cabinets shall be grounded to the telecommunications ground bus bar.

E. Mounting screws not used for installing patch panels and other hardware shall be bagged and left with the rack upon completion of the installation.

F. Contractor shall provide one (1) 25-count bag of rack screws per rack for the Owner. These screws are in addition to what will be used by the contractor to mount the equipment that they are contracted to install.

3.2 BACKBOARDS

A. Install backboards level and secure with hardware that is sufficient to support the load of the backboard and the equipment that will mounted on it. Also, make provisions for future equipment when calculating load weight.

3.3 IDENTIFICATION

A. Refer to Section 27 0553 - Identification for Communications Systems for labeling details.

END OF SECTION

SECTION 27 11 19

COMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the products and execution requirements relating to Communications Termination Blocks and Patch Panels.

C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

A. Provide product data from manufacturer's specifications.

1.3 WORK INCLUDED

A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

B. The work shall include, but not be limited to the following:

1. Furnish and install all patch panels.
2. Furnish and install all optical fiber panels/enclosures.
3. Furnish and install all termination blocks.
4. Furnish and install all PoE (Power-over-Ethernet) switches.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

A. Approved Patch Panel Manufacturer(s)

1. Leviton
2. OCC
3. Panduit
4. Middle Atlantic

B. Approved Optical Fiber Enclosure Manufacturer(s)

1. Leviton
2. OCC

3. Panduit
4. Middle Atlantic

C. Approved Termination Block Manufacturer(s)

1. Leviton
2. OCC
3. Panduit
4. Middle Atlantic

D. Approved PoE Switch Manufacturer(s)

1. Cisco
2. Allied Telesis
3. HP – ProCurve Series

2.2 PATCH PANELS

A. Category 6 Patch Panel

1. The Category 6 patch panel shall be compatible with 19" equipment racks, cabinets or wall mount brackets.
2. The Category 6 patch panel shall be equipped with 8-position modular ports and shall allow for termination using both T568A and T568B wiring schemes.
3. The Category 6 patch panel shall be equipped with front labeling space to facilitate port identification.
4. The connector module shall meet or exceed the Category 6 performance criteria per ANSI/TIA-568-C.2.

2.3 OPTICAL FIBER PANELS/ENCLOSURES

A. Rack Mount Optical Fiber Panel/Enclosure

1. The rack mount optical fiber panel/enclosure shall be equipped with either a swing out mechanism or a sliding drawer to access fibers.
2. The rack mount optical fiber panel/enclosure shall be capable of terminating tight-buffered or loose tube optical fiber cable.
3. The rack mount optical fiber panel/enclosure shall provide for bend radius control throughout the panel as well as storage space for slack cabling.
4. The panel/enclosure shall meet or exceed the performance criteria per ANSI/TIA-568-C.3.
5. The rack mount optical fiber panel/enclosure shall be equipped with optical fiber adapter panels.
    a. The optical fiber adapter panels shall accommodate either multimode or singlemode terminated optical fiber.
    b. The optical fiber adapter panels shall be compatible with LC connectors.
    c. OM3 laser optimized adaptors shall be aqua in color and equipped with zirconia ceramic sleeves.
    d. Singlemode adaptors shall be blue or green in color and equipped with zirconia ceramic sleeves.

B. Wall Mount Optical Fiber Panel/Enclosure

1. The wall mount optical fiber panel/enclosure shall have a hinged door for access, with locking available for security.
2. The wall mount optical fiber panel/enclosure shall be capable of terminating tight-buffered or loose tube optical fiber cables and all popular connector types.
3. The wall mount optical fiber panel/enclosure shall provide for bend radius control throughout the panel as well as storage space for slack cabling.
4. The panel/enclosure shall meet or exceed the performance criteria per ANSI/TIA-568-C.3.
    a. The wall mount optical fiber panel/enclosure shall be equipped with optical fiber adapter panels.
    b. The optical fiber adapter panels shall accommodate either multimode or singlemode terminated optical fiber.
    c. The optical fiber adapter panels shall be compatible with LC connectors.
    d. OM3 laser optimized adaptors shall be aqua in color and equipped with zirconia ceramic sleeves.
    e. Singlemode adaptors shall be blue or green in color and equipped with zirconia ceramic sleeves.

2.4 TERMINATION BLOCKS

A. 110 Type Wiring Blocks/Cross-Connect Kits

1. The 110-type wiring blocks shall be available in 100- and/or 300-pair configurations.
2. The 110-type wiring block shall be Category 6.
3. The cross-connect kits shall include all the components required to complete a wall-mounted 110 cross-connect installation and be available in both 100- and/or 300-pair configuration. (Includes 110-blocks, connecting blocks and designation strips).
4. The termination block shall meet or exceed the performance criteria per ANSI/TIA-568-C.2.
5. Backbone blocks shall use 5-pair connecting blocks on each 25-pair row.
6. Horizontal blocks shall use 4-pair connecting blocks on each 25-pair row.

B. 66-Blocks

1. The 66-type wiring block shall be a 50-pair configuration.
2. The 66-type wiring block shall have a split clip system using bridge clips to connect incoming pairs to outgoing pairs.
3. The 66 block’s labeling system shall use designation strips or covers to accommodate labels.

2.5 POE SWITCHES

1. Category 6 PoE Switch
    a. IEEE 802.3af Power over Ethernet compliant
    b. 2.68Mbps throughput
    c. 3.6Gbps switching capacity
    d. Broadcast storm control capability
    e. 20MB RAM minimum
    f. Auto MDI/MDI-X capability
    g. 95W minimum PoE budget
    h. 19” rack-mountable
    i. UL listed
    j. RoHS compliant
    k. Telnet remote login capability
    l. Non-blocking architecture

m. SNMP v1 and v2 compatibility
n. Wirespeed performance
o. Rapid Spanning-Tree capability
p. WPA-PSK (AES) IEEE 802.1X RADIUS capability
q. VLAN tagging
r. Port mirroring
s. Link aggregation – LACP capability
t. SNTP capability
u. GVRP capability

PART 3 - EXECUTION

3.1 PATCH PANELS AND POE SWITCHES

A. Cables shall be dressed and terminated in accordance with the recommendations made in ANSI/TIA-568-C.0 and/or ANSI/TIA-568-C.1, manufacturer's recommendations and best industry practice.

B. Pair untwist at the termination shall not exceed 13 mm (0.5 inch).

C. Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable.

D. Cables shall be neatly bundled and dressed to their respective patch panel or PoE switch. Each patch panel or PoE switch shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.

E. Each cable shall be clearly labeled on the cable jacket behind the patch panel or PoE switch at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

3.2 OPTICAL FIBER PANELS/ENCLOSURES

A. Cables shall be dressed and terminated in accordance with the recommendations made in ANSI/TIA-568-C.0 and/or ANSI/TIA-568-C.1, manufacturer's recommendations and best industry practices.

B. Each cable shall be individually attached to the respective splice enclosure by mechanical means. The cables strength member shall be securely attached the cable strain relief bracket in the enclosure.

C. Bend radius of the optic fiber cable in the panel/enclosure shall not exceed 10 times the outside diameter of the cable.

D. Each fiber bundle shall be stripped upon entering the splice tray and the individual fibers routed in the splice tray.

E. Each cable shall be clearly labeled at the entrance to the splice enclosure. Cables labeled within the bundle shall not be acceptable.

F. A maximum of 12 strands of fiber shall be spliced in each tray.

G. All spare strands shall be installed into spare splice trays.

H. Fiber slack shall be neatly coiled within the fiber splice tray or enclosure. No slack loops shall be allowed external to the fiber panel.

3.3 TERMINATION BLOCKS

A. Cables shall be dressed and terminated in accordance with the recommendations made in ANSI/TIA-568-C.0 and/or ANSI/TIA-568-C.1, manufacturer's recommendations and best industry practice.

B. Pair untwist at the termination shall not exceed 13 mm (0.5 inch).

C. Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable.

D. Cables shall be neatly bundled and dressed to their respective termination block. Each termination block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.

E. Each cable shall be clearly labeled on the cable jacket within 12" of the termination block at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

F. Wall mounted termination block fields shall be mounted on communications backboard.

G. Wall mounted termination block fields shall be installed as per the requirements specified by the manufacturer's installation guidelines.

3.4 IDENTIFICATION

A. Refer to Section 27 05 53 - Identification for Communications Systems for labeling details.

END OF SECTION

SECTION 27 11 23

COMMUNICATIONS CABLE MANAGEMENT AND LADDER RACK

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the products and execution requirements relating to Communications Cable Management and Ladder Rack.

C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

A. Provide product data from manufacturer's specifications.

1.3 WORK INCLUDED

A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

B. The work shall include, but not be limited to the following:

1. Furnish and install all horizontal cable management.
2. Furnish and install all vertical cable management.
3. Furnish and install ladder rack system.
4. Furnish and install all tie wraps/Velcro straps.
5. Furnish and install all C-rings/D-rings.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

A. Approved Horizontal Cable Management Manufacturer(s)

1. Chatsworth Products, Inc.
2. Middle Atlantic
3. Panduit
4. Or Approved Equal

B. Approved Vertical Cable Management Manufacturer(s)

1. Chatsworth Products, Inc.

2. Middle Atlantic
3. Panduit
4. Or Approved Equal

C. Approved Ladder Rack System Manufacturer(s)

1. Chatsworth Products, Inc.
2. Middle Atlantic
3. Hoffman
4. Or Approved Equal

D. Approved Tie Wrap/Velcro Strap Manufacturer(s)

1. Middle Atlantic
2. Panduit
3. Thomas & Betts
4. Or Approved Equal

E. Approved C-Ring/D-ring Manufacturer(s)

1. Chatsworth Products, Inc.
2. Middle Atlantic
3. Panduit
4. Or Approved Equal

2.2 CABLE MANAGEMENT - HORIZONTAL

A. Horizontal Cable Management

1. The horizontal wire manager shall be compatible with 19-inch equipment racks, cabinets or wall mount brackets.
2. The horizontal cable manager shall provide support for patch cords at the front of the panel.
3. The horizontal cable manager shall be 2 rack-units in height.

2.3 CABLE MANAGEMENT - VERTICAL

A. Vertical Cable Management

1. The vertical cable manger shall be double-sided.
2. The vertical cable manager shall provide support for patch cords at the front of the rack and wire management at the rear of the rack.
3. The vertical cable manager shall be a minimum width of 6".
4. Vertical cable manager color shall be black.

2.4 LADDER RACKS

A. Ladder Rack System

1. See Drawings for ladder rack system details.

2. The ladder rack system shall be securely mounted with hardware designed for use in ladder rack systems.
3. End caps shall be installed on the exposed ends of the ladder racks, channel supports and bolts. Protective covers shall be installed on threaded rods that come in contact with cabling plant.
4. Ladder Rack System color shall be black.

2.5 TIE WRAPS AND VELCRO STRAPS

A. Tie Wraps and Velcro Straps

1. Backbone cables shall be fastened to support structures with tie wraps/ Velcro straps.
2. Horizontal cables shall be fastened to support structures with Velcro straps.
   a. Tie Wrap color shall be black.
   b. Velcro Strap color shall be black.

2.6 C-RINGS/D-RINGS

A. C-Rings/D-rings

1. C-rings/D-rings shall be used on backboards to support cables, patch cords and cross-connect wire.
2. C-rings/D-rings shall be made of high-strength, fire-retardant material with rounded edges to prevent damage to cable and wire insulation.

PART 3 - EXECUTION

3.1 CABLE MANAGEMENT - HORIZONTAL

A. Horizontal cable managers shall be installed below patch panels in a 1:1 ratio (one horizontal cable manager per patch panel) and as indicated on Drawings.

3.2 CABLE MANAGEMENT - VERTICAL

A. Vertical cable managers shall be installed on both sides of a single equipment rack. Where two (2) or more racks are positioned in a row, vertical cable managers shall be installed between each rack and each end of the row.

3.3 LADDER RACKS

A. Ladder rack system shall be installed straight, level and perpendicular to walls and ceiling slabs.

B. Ladder racks shall be supported at 5' intervals maximum.

C. Provide all hardware, accessories, fasteners, anchors, threaded rods and support channels required to provide a complete ladder rack system.

D. See Drawings for ladder rack system details.

3.4 TIE WRAPS AND VELCRO STRAPS

A. Tie wraps/Velcro straps shall be installed around cables at intervals of 12" minimum.

B. Tie wraps shall secure cables to ladder racks using an “X” pattern.

C. Do not over-cinch cables.

3.5 C-RINGS/D-RINGS

A. C-ring/D-rings shall be installed on 3/4" backboard, straight and level.

3.6 IDENTIFICATION

A. Refer to Section 27 05 53 - Identification for Communications Systems for labeling details.

END OF SECTION

SECTION 27 11 26

COMMUNICATIONS RACK MOUNTED POWER PROTECTION AND POWER STRIPS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the products and execution requirements relating to Communications Rack Mounted Power Protection and Power Strips.

C. Product Specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

A. Provide product data from manufacturer's specifications.

1.3 WORK INCLUDED

A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

B. The work shall include, but not be limited to the following:

1. Furnish and install all power distribution units.
2. Furnish and install all rack mounted UPS.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

A. Approved Power Distribution Unit Manufacturer(s)

1. Leviton
2. Middle Geist
3. Geist
4. Or Approved Equal

B. Approved Rack Mounted UPS Manufacturer(s)

1. APC
2. Middle Atlantic
3. Tripp Lite
4. Or Approved Equal

2.2 POWER DISTRIBUTION UNITS

A. Power Distribution Unit

1. The power distribution unit shall be equipped with a minimum of twelve (12) 3-prong, 120 VAC outlets, 7' cord and an on/off switch.
2. The power distribution unit shall be equipped with surge protection with a 20 Amp current limit.
3. The power distribution unit shall be equipped with a bracket that enables it to be mounted on a 19" rack, cabinet or wall mount bracket without modification.

2.3 RACK MOUNTED UPS

A. 1500VA Rack Mounted UPS (IDF Rooms)

1. The rack mounted UPS shall have an output power capacity of 1,440VA/980W. Input/output voltage shall be 120V. Power cord length shall be eight (8) feet, minimum.
2. The rack mounted UPS shall be equipped with six (6) NEMA 5-15R output connections.
3. The rack mounted UPS shall have a surge energy rating of 459 joules and have a typical backup time of 7.4 minutes at full load.
4. The rack mounted UPS shall be 2 rack-units in height and able to mount to a 19" rack or cabinet without modification.

B. 3000VA Rack Mounted UPS (MDF Room or A/V Rooms)

1. The rack mounted UPS shall have an output power capacity of 3,000VA/2,100W. Input/output voltage shall be 208V. Output voltage shall be 120V/208V. Power cord length shall be ten (10 feet, minimum.
2. The rack mounted UPS shall be equipped with twelve (12) NEMA 5-20R, two (2) NEMA L6-20R and one (1) NEMA L6-30R output connections.
3. The rack mounted UPS shall have a surge energy rating of 480 joules and have a typical backup time of 14.1 minutes at full load.
4. The rack mounted UPS shall be 5 rack-units in height and able to mount to a 19" rack or cabinet without modification.

PART 3 - EXECUTION

3.1 POWER DISTRIBUTION UNITS

A. Power distribution units shall be installed as per the requirements specified by the manufacturer’s installation guidelines.

B. See Drawings for installation location on rack(s)/cabinet(s).

3.2 RACK MOUNTED UPS

A. Rack mounted UPS shall be installed as per the requirements specified by the manufacturer’s installation guidelines.

B. See Drawings for installation location on rack(s)/cabinet(s).

3.3 IDENTIFICATION

A. Refer to Section 27 05 53 - Identification for Communications Systems for labeling details.

END OF SECTION

SECTION 27 11 90

STRUCTURED MEDIA ENCLOSURES

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the products and execution requirements relating to Structured Media Enclosure requirements.

C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

D. Structured Media Enclosures shall be utilized within Extended-Stay unit types only.

1.2 SUBMITTALS

A. Provide product data from manufacturer's specifications.

1.3 WORK INCLUDED

A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

B. The work shall include, but not be limited to the following:

1. Furnish and install all structured media enclosures.
2. Furnish and install all voice and data modules.
3. Furnish and install all bridged voice modules.
4. Furnish and install all video splitters.

PART 2 - PRODUCTS

1.4 APPROVED PRODUCTS

A. Approved Structured Media Enclosure Manufacturer(s)

1. Leviton
2. Panduit
3. Suttle – SOHO Series
4. Primex – Verge Series
5. Or Approved Equal

B. Approved Voice and Data Module Manufacturer(s)

1. Leviton

2. Panduit
3. Suttle – SOHO Series
4. Primex
5. Or Approved Equal

C. Approved Bridged Voice Module Manufacturer(s)

1. Leviton
2. Panduit
3. Suttle – SOHO Series
4. Primex
5. Or Approved Equal

D. Approved Video Splitter Manufacturer(s)

1. Leviton
2. Panduit
3. Suttle – SOHO Series
4. Primex
5. Or Approved Equal

1.5 STRUCTURED MEDIA ENCLOSURE

A. The structured media enclosure shall be a one-piece (excluding cover) box made of white, RF-transparent plastic. It shall flush-mount with four wood screws (provided) on standard 16" center wall studs prior to dry wall.

B. The structured media enclosure shall have a minimum dimension of 30"h x 14"w x 3.5"d with 32"h x 16" cover.

C. The structured media enclosure shall meet all applicable standards: be UL Listed, comply with all ANSI/TIA-570-B requirements and meet FCC part 68.

1.6 VOICE AND DATA MODULE

A. The data module shall be Power Sum rated with a Power Sum NEXT performance equal to or better than the ANSI/TIA-568-C.2, Category 6 pair-to-pair NEXT performance specifications.

B. The data module shall be a printed circuit board module with no less than six (6) 8-position modular ports.

1.7 BRIDGED VOICE MODULE

A. The voice module shall be capable of bridging up to four (4) telephone lines through to nine (9) outlet locations (1 input block x 9 output blocks).

B. The voice module shall be a 110-style module with a printed circuit board.

1.8 VIDEO SPLITTERS

A. The Video Splitters shall be UL Listed. It shall be of die-cast housing and printed circuit board construction. Frequency Range 5 MHz - 1 GHz.

B. The in-unit splitter assignments shall be as follows:

1. One-bedroom and two-bedroom units shall be equipped with 4-way splitters.
2. Three-bedroom and higher units shall be equipped with 6-way splitters.

PART 3 - EXECUTION

1.9 STRUCTURED MEDIA ENCLOSURE

A. Structured Media Enclosures shall be installed as per the requirements specified by the manufacturer's installation guidelines and best industry practice.

B. Structured Media Enclosures shall be installed in accordance with the recommendations made in the ANSI/TIA-570-B standard.

C. Structured Media Enclosures shall be bonded and grounded in accordance with the recommendations made in the ANSI/TIA-607-B standard

END OF SECTION

SECTION 27 13 13

COMMUNICATIONS COPPER BACKBONE

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the products and execution requirements relating to Communications Copper Backbone.

C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

A. Provide product data from manufacturer's specifications.

1.3 WORK INCLUDED

A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

B. The work shall include, but not be limited to the following:

1. Furnish and install all copper backbone cable (inside plant).
2. Furnish and install all copper backbone cable (outside plant).

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

A. Approved Copper Backbone Cable (Inside Plant) Manufacturer(s)

1. Berk-Tek
2. General Cable
3. OCC
4. Superior Essex
5. Or Approved Equal

B. Approved Copper Backbone Cable (Outside Plant) Manufacturer(s)

1. Berk-Tek
2. General Cable

3. OCC
4. Superior Essex
5. Or Approved Equal

2.2 COPPER BACKBONE CABLE (INSIDE PLANT)

A. 100-Ohm Balanced Twisted Pair Building Backbone Cables (Inside Plant)

1. Generic Characteristics
   a. The inside plant, balanced twisted pair building backbone cable shall meet the 100-Ohm balanced twisted pair backbone requirements per the latest issue of ANSI/TIA-568-C.2.
   b. The inside plant, 100-Ohm balanced twisted pair cable shall be CMR or CMP rated (according to the space it occupies).
   c. The inside plant, balanced twisted pair building backbone cable core shall consist of 25-pair sub-units.

2.3 COPPER BACKBONE CABLE (OUTSIDE PLANT)

A. 100-Ohm PE-89 Backbone Cables (Outside Plant)

1. Generic Characteristics
   a. The outside plant backbone cable shall be assigned the RUS designation of PE-89.
   b. The outside plant backbone cable core shall consist of 25-pair sub-units.
   c. The outside plant backbone cable shall contain water-blocking gel and have a jacket made of polyethylene.

PART 3 - EXECUTION

3.1 BACKBONE CABLES (INSIDE PLANT)

A. Cables shall be dressed and terminated in accordance with the recommendations made in ANSI/TIA-568-C.0 and/or ANSI/TIA-568-C.1, manufacturer’s recommendations and best industry practices.

B. Backbone cables shall be installed separately from horizontal distribution cables

C. A plastic or nylon pull cord with a minimum test rating of 90 Kg (200 lb.) shall be co-installed with all cable installed in any conduit.

D. Where cables are housed in conduits, the backbone and horizontal cables shall be installed in separate conduits

E. Exposed cables must be CMP or MMP rated if installed in an air return plenum. CMR rated cables shall be installed in metallic conduit if installed in an air return plenum.

F. Where backbone cables and distribution cables are installed in a cable tray or wireway, backbone cables shall be installed first and bundled separately from the horizontal distribution cables.

G. Leave 10' of slack on each end of copper backbone cable.

H. Backbone cables spanning more than three floors shall be securely attached at the top of the cable run with a wire mesh grip and on alternating floors or as required by local codes.

I. Vertical runs of cable shall be supported to messenger strand, cable ladder, or other method to provide proper support for the weight of the cable.

J. Large bundles of cables and/or heavy cables shall be attached using metal clamps and/or metal banding to support the cables.

K. The cable's minimum bend radius and maximum pulling tension shall not be exceeded. Refer to manufacturer's requirements.

L. Copper cables shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.

M. Each copper cable shall be clearly labeled on the cable jacket behind the patch panel or block at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

N. Copper backbone cables shall be installed separately from horizontal distribution cables

3.2 BACKBONE CABLES (OUTSIDE PLANT)

A. All OSP cables brought to the Entrance Facilities shall have 15 ft. of slack coiled and secured to the wall in the proximity of the termination field.

B. All cables shall be tagged and identified within each handhole/maintenance hole.

C. Place initial cables in bottom conduits to facilitate easy subsequent cable placement.

D. Place leader guard in the duct before placing cable to prevent damaging the cable sheath on the sharp edge of the duct.

E. Ventilate maintenance where gas has been detected before entering the maintenance hole.

F. A 600 lb. break-away swivel, along with a slip clutch capstan winch that shows the dynamometer (pulling tension) reading, shall be used at all times during pulling.

G. At each splice location the cable ends will be sealed watertight at all times. Reels will be continuously manned during cable installation.

H. Copper backbone cables shall be bonded and grounded in accordance with the recommendations made in the ANSI/TIA-607-B standard, manufacturer's recommendations and best industry practice.

3.3 IDENTIFICATION

A. Refer to Section 27 05 53 - Identification for Communications Systems for labeling details.

END OF SECTION

SECTION 27 13 23

COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the products and execution requirements relating to Communications Optical Fiber Backbone Cabling.

C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

A. Provide product data from manufacturer's specifications.

1.3 WORK INCLUDED

A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

B. The work shall include, but not be limited to the following:

1. Furnish and install all optical fiber backbone cable (inside plant).
2. Furnish and install optical fiber backbone cable (outside plant).
3. Furnish and install all optical fiber connectors.
4. Perform all optical fiber splices.
5. Furnish and install all splice cases.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

A. Approved Optical Fiber Backbone Cable (Inside Plant) Manufacturer(s)

1. Berk-Tek/Leviton
2. OCC
3. Panduit
4. CommScope
5. Belden
6. Corning
7. Or Approved Equal

B. Approved Optical Fiber Backbone Cable (Outside Plant) Manufacturer(s)

1. Berk-Tek/Leviton
2. OCC
3. Panduit
4. CommScope
5. Belden
6. Corning
7. Or Approved Equal

C. Approved Optical Fiber Connectivity Manufacturer(s)

1. Leviton
2. OCC
3. Panduit
4. CommScope
5. Belden
6. Corning
7. Or Approved Equal

D. Approved Splice Case Manufacturer(s)

1. Leviton
2. OCC
3. Panduit
4. CommScope
5. Belden
6. Corning
7. Or Approved Equal

2.2 OPTICAL FIBER BACKBONE CABLE (INSIDE PLANT)

A. Enhanced Singlemode Fiber Optic Cabling (OS2) Tight-Buffered

1. Generic Characteristics
   a. The fiber optic cabling shall be available with a minimum of twelve (12) 900-micron fibers placed in a color-coded sub-unit bundle with aramid strength elements.
   b. The fiber optic cabling shall meet or exceed the performance criteria found in ANSI/TIA-568-C.3.
   c. The fiber optic cabling shall have sequential length markings printed on the cable jacket.
   d. All singlemode fibers shall be pigtail spliced into a rack mounted optical fiber enclosure or wall-mounted enclosure.
   e. The maximum cable attenuation of fiber shall not exceed 0.5 dB per kilometer @ 1550 nm and 0.5 dB per kilometer @ 1310 nm.
   f. The fiber optic cabling shall have minimum 1 GbE transmission distance of >5000 m at 1310 nm.
   g. The fiber optic cabling shall have minimum 10 GbE transmission distance of >10000 m at 1310 nm.
   h. Plenum-rated (OFNP) fiber optic cabling shall be utilized in all plenum spaces, no exceptions; otherwise, riser-rated (OFNR) fiber optic cabling may be utilized where allowable.

B. Enhanced Singlemode Fiber Optic Cabling (OS2) Loose-Tube

1. Generic Characteristics
   a. The fiber optic cabling shall be available with a minimum of twelve (12) 250-micron fibers placed in a color-coded sub-unit bundle with aramid strength elements.
   b. The fiber optic cabling shall meet or exceed the performance criteria found in ANSI/TIA-568-C.3.
   c. The fiber optic cabling shall have sequential length markings printed on the cable jacket.
   d. All singlemode fibers shall be pigtail spliced into a rack mounted optical fiber enclosure or wall-mounted enclosure.
   e. The maximum cable attenuation of fiber shall not exceed 0.3 dB per kilometer @ 1550 nm and 0.4 dB per kilometer @ 1310 nm.
   f. The fiber optic cabling shall have minimum 1 GbE transmission distance of >5000 m at 1310 nm.
   g. The fiber optic cabling shall have minimum 10 GbE transmission distance of >10000 m at 1310 nm.
   h. Plenum-rated (OFNP) fiber optic cabling shall be utilized in all plenum spaces, no exceptions; otherwise, riser-rated (OFNR) fiber optic cabling may be utilized where allowable.

C. 50/125 Multimode Fiber Optic Cabling (OM4) Tight-Buffered

1. Generic Characteristics
   a. The fiber optic cabling shall be available with a minimum of twelve (12) 900-micron fibers placed in a color-coded sub-unit bundle with aramid strength elements.
   b. The fiber optic cabling shall meet or exceed the performance criteria found in ANSI/TIA-568-C.3.
   c. The fiber optic cabling shall have sequential length markings printed on the cable jacket.
   d. The maximum cable attenuation of fiber shall not exceed 0.8 dB per kilometer @ 1300 nm and 2.8 dB per kilometer @ 850 nm.
   e. The fiber optic cabling shall have minimum 1 GbE transmission distance of 1040 m at 850 nm.
   f. The fiber optic cabling shall have minimum 10 GbE transmission distance of 550 m at 850 nm.
   g. The fiber optic cabling shall have minimum overfilled bandwidth 500 MHz-km @ 1300 nm.
   h. The fiber optic cabling shall have minimum modal bandwidth 4700 MHz-km @ 850 nm.
   i. Plenum-rated (OFNP) fiber optic cabling shall be utilized in all plenum spaces, no exceptions; otherwise, riser-rated (OFNR) fiber optic cabling may be utilized where allowable.

2.3 OPTICAL FIBER BACKBONE CABLE (OUTSIDE PLANT)

A. Enhanced Singlemode Fiber Optic Cabling (OS2) Tight-Buffered

1. Generic Characteristics
   a. The fiber optic cabling shall be available with a minimum of twelve (12) 900-micron fibers placed in a color-coded sub-unit bundle with moisture-blocking gel within armored jacketing.
   b. The fiber optic cabling shall meet or exceed the performance criteria found in ANSI/TIA-568-C.3.
   c. The fiber optic cabling shall have sequential length markings printed on the cable jacket.
   d. All singlemode fibers shall be pigtail spliced into a rack mounted optical fiber enclosure or wall-mounted enclosure.

e. The maximum cable attenuation of fiber shall not exceed 0.5 dB per kilometer @ 1550 nm and 0.5 dB per kilometer @ 1310 nm.
f. The fiber optic cabling shall have minimum 1 GbE transmission distance of >5000 m at 1310 nm.
g. The fiber optic cabling shall have minimum 10 GbE transmission distance of >10000 m at 1310 nm.

B. Enhanced Singlemode Fiber Optic Cabling (OS2) Loose-Tube

1. Generic Characteristics
   a. The fiber optic cabling shall be available with a minimum of twelve (12) 250-micron fibers placed in a color-coded sub-unit bundle with moisture-blocking gel within armored jacketing.
   b. The fiber optic cabling shall meet or exceed the performance criteria found in ANSI/TIA-568-C.3.
   c. The fiber optic cabling shall have sequential length markings printed on the cable jacket.
   d. All singlemode fibers shall be pigtail spliced into a rack mounted optical fiber enclosure or wall-mounted enclosure.
   e. The maximum cable attenuation of fiber shall not exceed 0.3 dB per kilometer @ 1550 nm and 0.4 dB per kilometer @ 1310 nm.
   f. The fiber optic cabling shall have minimum 1 GbE transmission distance of >5000 m at 1310 nm.
   g. The fiber optic cabling shall have minimum 10 GbE transmission distance of >10000 m at 1310 nm.

C. 50/125 Multimode Fiber Optic Cabling (OM4) Tight-Buffered

1. Generic Characteristics
   a. The fiber optic cabling shall be available with a minimum of twelve (12) 900-micron fibers placed in a color-coded sub-unit bundle with moisture-blocking gel within armored jacketing.
   b. The fiber optic cabling shall meet or exceed the performance criteria found in ANSI/TIA-568-C.3.
   c. The fiber optic cabling shall have sequential length markings printed on the cable jacket.
   d. The maximum cable attenuation of fiber shall not exceed 0.8 dB per kilometer @ 1300 nm and 2.8 dB per kilometer @ 850 nm.
   e. The fiber optic cabling shall have minimum 1 GbE transmission distance of 1040 m at 850 nm.
   f. The fiber optic cabling shall have minimum 10 GbE transmission distance of 550 m at 850 nm.
   g. The fiber optic cabling shall have minimum overfilled bandwidth 500 MHz-km @ 1300 nm.
   h. The fiber optic cabling shall have minimum modal bandwidth 4700 MHz-km @ 850 nm.

2.4 OPTICAL FIBER CONNECTORS

A. Laser Optimized Multimode Fiber Connectivity (OM4)

1. The fiber optic field-installable connector shall be LC for installation onto multimode laser optimized 50/125-micron fiber.
2. The fiber optic field-installable connector shall be compatible with 900-micron tight-buffered fibers.
3. The fiber optic field-installable connector shall meet or exceed the performance criteria found in ANSI/TIA-568-C.3.
4. The fiber optic field-installable connector shall have a maximum Loss of 0 .5 dB.

5. The fiber optic adapter module that occupies the faceplate shall be equipped with zirconia sleeve.
6. Laser optimized multimode connector color shall be aqua unless otherwise noted.

B. Singlemode Fiber Connectivity (OS2)

1. The fiber optic field-installable connector shall be LC for installation onto singlemode 9/125-micron fiber.
2. The optical fiber field-installable connector shall meet or exceed the performance criteria found in ANSI/TIA-568-C.3.
3. The fiber optic field-installable connector shall be compatible with 900-micron buffered fibers or 250-micron loose-tube fibers.
4. The preferred method of terminating loose-tube singlemode fiber is pigtail splicing into a rack mounted optical fiber panel or wall-mounted enclosure. Pigtails shall be factory terminated and 3 meters in length. A fiber enclosure with slack storage trays must be used when pigtail-splicing method is used.
5. The fiber optic adapter module that occupies the faceplate shall be equipped with zirconia sleeve.
6. The splice loss through each connector pair shall not exceed 0.50 dB.
7. Singlemode connector color shall be blue unless otherwise noted.

2.5 SPLICE CASES

A. Canister Splice Case

1. Splice cases shall be watertight and designed for outside plant applications.
2. All splice trays, seals and hardware shall be from the same manufacturer as the splice case.
3. Splice trays shall utilize heat-shrink seals.
4. See Drawings for size requirements.

PART 3 - EXECUTION

3.1 BACKBONE CABLES (INSIDE PLANT)

A. Cables shall be dressed and terminated in accordance with the recommendations made in ANSI/TIA-568-C.0 and/or ANSI/TIA-568-C.1, manufacturer’s recommendations and best industry practices.

B. Backbone cables shall be installed separately from horizontal distribution cables

C. A plastic or nylon pull cord with a minimum test rating of 90 Kg (200 lb.) shall be co-installed with all cable installed in any conduit.

D. Where cables are housed in conduits, the backbone and horizontal cables shall be installed in separate conduits

E. Exposed cables must be CMP or MMP rated if installed in an air return plenum. Riser rated cables shall be installed in metallic conduit if installed in an air return plenum.

F. Where backbone cables and distribution cables are installed in a cable tray or wireway, backbone cables shall be installed first and bundled separately from the horizontal distribution cables.

G. Leave 10' of slack on each end of fiber backbone cable.

H. Backbone cables spanning more than three floors shall be securely attached at the top of the cable run with a wire mesh grip and on alternating floors or as required by local codes.

I. Vertical runs of cable shall be supported to messenger strand, cable ladder, or other method to provide proper support for the weight of the cable.

J. Large bundles of cables and/or heavy cables shall be attached using metal clamps and/or metal banding to support the cables.

K. The cable's minimum bend radius and maximum pulling tension shall not be exceeded. Refer to manufacturer's requirements.

L. Each optical fiber cable shall be individually attached to the respective enclosure by mechanical means. The cables strength member shall be securely attached the cable strain relief bracket in the enclosure.

M. Each optical fiber cable shall be clearly labeled at the entrance to the enclosure. Cables labeled within the bundle shall not be acceptable.

N. Each fiber bundle shall be stripped upon entering the splice tray and the individual fibers routed in the splice tray.

O. A maximum of 12 strands of fiber shall be spliced in each tray.

P. All spare fiber strands shall be installed into spare splice trays.

Q. Fiber slack shall be neatly coiled within the fiber splice tray or enclosure. No slack loops shall be allowed external to the fiber panel.

3.2 BACKBONE CABLES (OUTSIDE PLANT)

A. All OSP cables brought to the Entrance Facilities shall have 15 ft. of slack coiled and secured to the wall in the proximity of the fiber enclosure.

B. All cables shall be tagged and identified within each handhole/maintenance hole.

C. Place initial cables in bottom conduits to facilitate easy subsequent cable placement.

D. Place leader guard in the duct before placing cable to prevent damaging the cable sheath on the sharp edge of the duct.

E. Ventilate maintenance where gas has been detected before entering the maintenance hole.

F. To ensure that the optical fiber cable's qualities and characteristics are not degraded during installation, excessive pulling tensions and short bending radii will not be allowed. The maximum pulling tension is 600 lbs. The minimum bending radius for cable under tension is 20 times the outside diameter of the cable and for cable at rest is 10 times the outside diameter of the cable.

G. A 600 lb. break-away swivel, along with a slip clutch capstan winch that shows the dynamometer (pulling tension) reading, shall be used at all times during pulling.

H. At each splice location the cable ends will be sealed watertight at all times. Reels will be continuously manned during cable installation.

I. Contractor shall coil 60 feet of spare optical fiber cable in each handhole/ maintenance hole without a splice and 75 feet of each optical fiber cable in each handhole/maintenance hole with a splice. Cable coils shall have at least two points of support on the optical fiber racking system.

J. When mounting the optical fiber slack coils, the minimum bend radius shall not be exceeded; this radius is equal to 10 times the outside diameter of the cable in a static application and 20 times the outside diameter in a dynamic application. At any time during the entire handling process of the optical fiber cable, as much care as possible should be maintained and all the manufacturer's recommendations should be followed.

3.3 OPTICAL FIBER CONNECTIVITY/SPLICING

A. Optical fiber connectors shall be installed as per the requirements specified by the manufacturer's installation guidelines.

B. All splicing shall be of the fusion type made under Light Injection and Detection Mode, whenever applicable. The Contractor shall provide certified and experienced personnel for splicing.

C. Contractor's tools and equipment shall be in excellent working order. Any worn or improperly working tools shall be discarded and not used on this project. All fusion splicers shall be calibrated and labeled according to the manufacturer's specifications. Contractor shall submit certification of calibration for the fusion splicers to the Engineer.

3.4 SPLICE CASES

A. Splice Cases shall be installed as per the requirements specified by the manufacturer's installation guidelines.

3.5 IDENTIFICATION

A. Refer to Section 27 05 53 - Identification for Communications Systems for labeling details.

END OF SECTION

SECTION 27 15 13

COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the products and execution requirements relating to Communications Copper Horizontal Cabling.

C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

A. Provide product data from manufacturer's specifications.

1.3 WORK INCLUDED

A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

B. The work shall include, but not be limited to the following:

1. Furnish and install all horizontal copper cable.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

A. Approved Horizontal Copper Cable Manufacturer(s)

1. Berk-Tek
2. General Cable
3. OCC
4. Superior Essex
5. Or Approved Equal

2.2 HORIZONTAL COPPER CABLE

A. 100 OHM Category 6 Balanced Twisted Pair Cable

1. The horizontal balanced twisted pair cable shall meet or exceed the Category 6 transmission characteristics per issue of ANSI/TIA/EIA-568-C.2.
2. Cable jacket shall be CMR or CMP rated (according to the space it occupies).
3. Jacket color shall be:
   a. Gray for voice.
   b. Blue for data

PART 3 - EXECUTION

3.1 HORIZONTAL CABLES

A. Cable shall be installed in accordance with manufacturer's recommendations and best industry practices.

B. A plastic or nylon pull cord with a minimum test rating of 90 Kg (200 lb.) shall be co-installed with all cable installed in any conduit.

C. Cable raceways shall not be filled greater than the ANSI/TIA/EIA-569-B maximum fill for the particular raceway type.

D. Cables shall be installed in continuous lengths from origin to destination (no splices) except for transition points, or consolidation points.

E. Riser rated cable shall be installed in metallic conduit when installed in a plenum space.

F. Where transition points or consolidation points are allowed, they shall be located in accessible locations and housed in an enclosure intended and suitable for the purpose.

G. The cable's minimum bend radius and maximum pulling tension shall not be exceeded. Refer to manufacturer's requirements.

H. If a J-hook or trapeze system is used to support cable bundles all horizontal cables shall be supported at a maximum of 48 to 60 inch (1.2 to 1.5 meter) intervals. At no point shall cable(s) rest on acoustic ceiling grids or panels.

I. Horizontal distribution cables shall be bundled in groups of no more than 50 cables. Cable bundle quantities in excess of 50 cables may cause deformation of the bottom cables within the bundle and degrade cable performance.

J. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.

K. Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, the Contractor shall install appropriate carriers to support the cabling.

L. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the Contractor prior to final acceptance at no cost to the Owner.

M. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-C.2 document, manufacturer's recommendations and best industry practices.

N. Leave a minimum of 12" of slack for twisted pair cables at the outlet. Cables shall be coiled in the in-wall box, surface-mount box or modular furniture raceway if adequate space is present to house the cable coil without exceeding the manufacturers bend radius. In hollow-wall installations where box-eliminators are used, excess wire can be stored in the wall. Excess slack shall be loosely coiled and stored in the ceiling above each drop location when there is not enough space present in the outlet box to store slack cable.

O. Cables shall be neatly bundled and dressed to their respective termination device. Each terminating device shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.

P. Each cable shall be clearly labeled on the cable jacket behind the termination device at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

3.2 IDENTIFICATION

A. Refer to Section 27 0553 - Identification for Communications Systems for labeling details.

END OF SECTION

SECTION 27 15 23

COMMUNICATIONS OPTICAL FIBER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the products and execution requirements relating to Communications Optical Fiber Horizontal Cabling.

C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

A. Provide product data from manufacturer’s specifications.

1.3 WORK INCLUDED

A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the specification or not.

B. The work shall include, but not be limited to the following:

1. Furnish and install all horizontal optical fiber cable.

PART 2 - PRODUCTS

A. APPROVED PRODUCTS

B. Approved Horizontal Optical Fiber Cable Manufacturer(s)

1. Berk-Tek/Leviton
2. OCC
3. Panduit
4. CommScope
5. Belden
6. Corning
7. Or Approved Equal

2.2 HORIZONTAL OPTICAL FIBER CABLE

A. Enhanced Singlemode Fiber Optic Cabling (OS2) Tight-Buffered

B. Generic Characteristics

1. The fiber optic cabling shall be available with a minimum of twelve (12) 900-micron fibers placed in a color-coded sub-unit bundle with aramid strength elements.
2. The fiber optic cabling shall meet or exceed the performance criteria found in ANSI/TIA-568-C.3.
3. The fiber optic cabling shall have sequential length markings printed on the cable jacket.
4. All singlemode fibers shall be pigtail spliced into a rack mounted optical fiber enclosure or wall-mounted enclosure.
5. The maximum cable attenuation of fiber shall not exceed 0.5 dB per kilometer @ 1550 nm and 0.5 dB per kilometer @ 1310 nm.
6. The fiber optic cabling shall have minimum 1 GbE transmission distance of >5000 m at 1310 nm.
7. The fiber optic cabling shall have minimum 10 GbE transmission distance of >10000 m at 1310 nm.
8. Plenum-rated (OFNP) fiber optic cabling shall be utilized in all plenum spaces, no exceptions; otherwise, riser-rated (OFNR) fiber optic cabling may be utilized where allowable.

C. 50/125 Multimode Fiber Optic Cabling (OM4) Tight-Buffered

D. Generic Characteristics

1. The fiber optic cabling shall be available with a minimum of twelve (12) 900-micron fibers placed in a color-coded sub-unit bundle with aramid strength elements.
2. The fiber optic cabling shall meet or exceed the performance criteria found in ANSI/TIA-568-C.3.
3. The fiber optic cabling shall have sequential length markings printed on the cable jacket.
4. The maximum cable attenuation of fiber shall not exceed 0.8 dB per kilometer @ 1300 nm and 2.8 dB per kilometer @ 850 nm.
5. The fiber optic cabling shall have minimum 1 GbE transmission distance of 1040 m at 850 nm.
6. The fiber optic cabling shall have minimum 10 GbE transmission distance of 550 m at 850 nm.
7. The fiber optic cabling shall have minimum overfilled bandwidth 500 MHz-km @ 1300 nm.
8. The fiber optic cabling shall have minimum modal bandwidth 4700 MHz-km @ 850 nm.
9. Plenum-rated (OFNP) fiber optic cabling shall be utilized in all plenum spaces, no exceptions; otherwise, riser-rated (OFNR) fiber optic cabling may be utilized where allowable.

PART 3 - EXECUTION

3.1 HORIZONTAL CABLES

A. Cable shall be installed in accordance with manufacturer’s recommendations and best industry practices.

B. A plastic or nylon pull cord with a minimum test rating of 90 Kg (200 lb.) shall be co-installed with all cable installed in any conduit.

C. Cable raceways shall not be filled greater than the ANSI/TIA-569-B maximum fill for the particular raceway type.

D. Cables shall be installed in continuous lengths from origin to destination (no splices) except for transition points, or consolidation points.

E. Riser rated cable shall be installed in metallic conduit when installed in a plenum space.

F. Where transition points or consolidation points are allowed, they shall be located in accessible locations and housed in an enclosure intended and suitable for the purpose.

G. The cable's minimum bend radius and maximum pulling tension shall not be exceeded. Refer to manufacturer's requirements.

H. If a J-hook or trapeze system is used to support cable bundles all horizontal cables shall be supported at a maximum of 48 to 60 inch (1.2 to 1.5 meter) intervals. At no point shall cable(s) rest on acoustic ceiling grids or panels.

I. Horizontal distribution cables shall be bundled in groups of no more than 50 cables. Cable bundle quantities in excess of 50 cables may cause deformation of the bottom cables within the bundle and degrade cable performance.

J. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.

K. Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, the Contractor shall install appropriate carriers to support the cabling.

L. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the Contractor prior to final acceptance at no cost to the Owner.

M. Cables shall be dressed and terminated in accordance with the recommendations made in ANSI/TIA-568-C.0 and/or ANSI/TIA-568-C-1, manufacturer's recommendations and best industry practices.

N. Leave a minimum of 36" of slack for optical fiber at the outlet. Cables shall be coiled in the in-wall box, surface-mount box or modular furniture raceway if adequate space is present to house the cable coil without exceeding the manufacturers bend radius. Excess slack shall be loosely coiled and stored in the ceiling above each drop location where there is not enough space present in the outlet box to store slack cable.

O. Cables shall be neatly bundled and dressed to their respective termination device. Each terminating device shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.

P. Each cable shall be clearly labeled on the cable jacket behind the termination device at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

3.2 IDENTIFICATION

A. Refer to Section 27 0553 - Identification for Communications Systems for labeling details.

END OF SECTION

SECTION 27 15 43

COMMUNICATIONS FACEPLATES AND CONNECTORS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the products and execution requirements relating to Communications Faceplates and Connectors.

C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

A. Provide product data from manufacturer’s specifications.

1.3 WORK INCLUDED

A. The work included under this Specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

B. The work shall include, but not be limited to the following:

1. Furnish and install all copper connectivity.
2. Furnish and install all optical fiber connectivity.
3. Furnish and install all coaxial connectivity.
4. Furnish and install all faceplates.
5. Furnish and install all surface mount boxes.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

A. Approved Copper Connectivity Manufacturer(s)

1. Leviton
2. OCC
3. Panduit
4. CommScope
5. Belden
6. Corning
7. Or Approved Equal

B. Approved Optical Fiber Connectivity Manufacturer(s)

1. Leviton
2. OCC
3. Panduit
4. CommScope
5. Belden
6. Corning
7. Or Approved Equal

C. Approved Coaxial Connectivity Manufacturer(s)

1. Cable Connectors
   a. Leviton
   b. OCC
   c. Panduit
   d. CommScope
   e. Belden
   f. Corning
   g. Or Approved Equal

2. F-Connectors
   a. Leviton
   b. Panduit
   c. CommScope
   d. Belden
   e. Or Approved Equal

D. Approved Faceplate Manufacturer(s)

1. Leviton
2. Panduit
3. CommScope
4. Belden
5. Or Approved Equal

E. Approved Surface Mount Box manufacturer(s)

1. Leviton
2. Panduit
3. CommScope
4. Belden
5. Or Approved Equal

2.2 COPPER CONNECTIVITY

A. Voice/Data Jacks

1. RJ45 Category 6/6A, 8-Position, 8-Contact (8P8C) Modular Jack
   a. The connector module shall meet or exceed the Category 6/6A performance criteria per ANSI/TIA-568-C.2.

b. The eight-position connector module shall accommodate six-position modular plug modular cords without damage to either the cord or the module.
c. The connector module shall be designed for use at the work area (WA), communications room (TR) and/or equipment room (ER) without modification.
d. The connector module shall be available in both the T568A and T568B wiring configurations within the same module.
e. The connector module shall have an insulation displacement connection featuring insulation slicing of 22 to 24 AWG plastic-insulated solid copper conductors forming a gas-tight connection.
f. Icons shall be used if offered from the manufacturer.
g. Unless otherwise noted in plans or specifications (or by Owner design standards), jack/icon color shall be:
    1) Gray for voice.
    2) Blue for data

2.3 FIBER CONNECTIVITY

A. Laser Optimized Multimode Fiber Connectivity (OM4)

1. The fiber optic field-installable connector shall be LC for installation onto multimode laser optimized 50/125-micron fiber.
2. The fiber optic field-installable connector shall be compatible with 900-micron tight-buffered fibers.
3. The fiber optic field-installable connector shall meet or exceed the performance criteria found in ANSI/TIA-568-C.3.
4. The fiber optic field-installable connector shall have a maximum Loss of 0 .5 dB.
5. The fiber optic adapter module that occupies the faceplate shall be equipped with zirconia sleeve.
6. Laser optimized multimode connector color shall be aqua unless otherwise noted.

B. Singlemode Fiber Connectivity (OS2)

1. The fiber optic field-installable connector shall be LC for installation onto singlemode 9/125-micron fiber.
2. The optical fiber field-installable connector shall meet or exceed the performance criteria found in ANSI/TIA-568-C.3.
3. The fiber optic field-installable connector shall be compatible with 900-micron buffered fibers or 250-micron loose-tube fibers.
4. The preferred method of terminating loose-tube singlemode fiber is pigtail splicing into a rack mounted optical fiber panel or wall-mounted enclosure. Pigtails shall be factory terminated and 3 meters in length. A fiber enclosure with slack storage trays must be used when pigtail-splicing method is used.
5. The fiber optic adapter module that occupies the faceplate shall be equipped with zirconia sleeve.
6. The splice loss through each connector pair shall not exceed 0.50 dB.
7. Singlemode connector color shall be blue unless otherwise noted.

2.4 COAXIAL CONNECTIVITY

A. Connectors shall be solderless, 75-Ohm impedance and be designed for the specific type of cable used.

B. Series-6 connectors shall be one piece. Series-11 connectors shall use the cable’s center conductor as the connector’s center pin.

C. All Series-6 and Series-11 connections shall be made with compression-type connectors.

D. Screw-on connectors are not acceptable.

E. The coaxial adapter module that occupies the faceplate shall be a 75-ohm, F-type connector.

2.5 FACEPLATES

A. Faceplates

1. The faceplate housing the connector modules shall have no visible mounting screws.
2. Faceplates shall be midsize.
3. It shall be possible to install the connector modules in wall-mounted single- and dual-gang electrical boxes, utility poles and modular furniture (cubicle) access points using manufacturer-supplied faceplates and/or adapters.
4. The faceplate housing the connector modules shall have the option of being mounted on adapter boxes for surface mount installation.
5. The faceplate housing the connector modules shall have a labeling capability using built-in labeling windows, to facilitate outlet identification and ease network management.
6. The faceplate housing the connector modules shall provide flexibility in configuring multimedia workstation outlets that respond to present or future network needs such as audio, video, coaxial and optical fiber applications.
7. Color shall be same as electrical faceplates. Coordinate with Architect.

2.6 SURFACE MOUNT BOXES

A. The surface mount box shall accommodate connections of any type, UTP, optical fiber or coax.

B. The surface mount box shall have internal storage space for slack cabling and a built-in spool for controlling cable bend radius.

C. Color shall be same as electrical faceplates. Coordinate with Architect.

PART 3 - EXECUTION

3.1 COPPER CONNECTIVITY

A. RJ45 8-position, 8-contact (8P8C) modular jacks shall be installed in accordance with manufacturer's recommendations and installation guides, and best industry practices.

B. Pair untwist at the termination shall not exceed 13 mm (0.5 inch).

C. Data jacks, unless otherwise noted in Drawings or fiber adapter modules are present, shall be located in the bottom position(s) of each faceplate. Data jacks in horizontally oriented faceplates shall occupy the right-most position(s).

D. Voice jacks, unless otherwise noted in Drawings, shall occupy the top position(s) on the faceplate. Voice jacks in horizontally oriented faceplates shall occupy the left-most position(s).

3.2 OPTICAL FIBER CONNECTIVITY

A. Optical fiber connectors shall be installed in accordance with manufacturer's recommendations and installation guides, and best industry practices.

B. Fiber adapter modules, unless otherwise noted in Drawings, shall be located in the bottom position(s) of each faceplate. Fiber adapter modules in horizontally oriented faceplates shall occupy the right-most position(s).

3.3 COAXIAL CONNECTIVITY

A. F-connectors shall be installed in accordance with manufacturer's recommendations and installation guides, and best industry practices.

B. Cable preparation and connector application shall be done only with tools approved for use with the connector.

3.4 FACEPLATES

A. Blank inserts shall be installed where ports are not used.

B. The same orientation and positioning of jacks and connectors shall be utilized throughout the installation.

C. Faceplates shall be installed straight and level.

D. Faceplates shall be installed at heights as noted on the Drawings and same as electrical faceplates. Coordinate with electrical and Architect.

3.5 SURFACE MOUNT BOXES

A. Blank inserts shall be installed where ports are not used.

B. The same orientation and positioning of jacks and connectors shall be utilized throughout the installation.

C. Surface mount boxes shall be installed straight and level.

D. Surface mount shall be installed at heights as noted on the Drawings.

3.6 IDENTIFICATION

A. Refer to Section 27 05 53 - Identification for Communications Systems for labeling details.

END OF SECTION

SECTION 27 16 19

COMMUNICATIONS PATCH CORDS AND STATION CORDS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the products and execution requirements relating to Voice and Data Cross-Connect/Patching Equipment.

C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

A. Provide product data from manufacturer's specifications.

1.3 WORK INCLUDED

A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

B. The work hall include, but not be limited to the following:

1. Furnish and install all copper patch cords/station cords.
2. Furnish and install fiber patch cords/station cords.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

A. Approved Copper Patch Cord/Station Cord Manufacturer(s)

1. General Cable
2. OCC
3. Superior Essex
4. Or Approved Equal

B. Approved Fiber Patch Cord/Station Cord Manufacturer(s)

1. Berk-Tek
2. General Cable
3. OCC
4. Superior Essex

5. Or Approved Equal

2.2 COPPER PATCH CORDS/STATION CORDS

A. Category 6 Patch Cords/Station Cords

1. The Category 6 patch cord/station cord shall be 4-pair, with 24 AWG solid or stranded copper conductors and 8-position modular plug.
2. The Category 6 modular cord cable shall be UL Listed as Type CMR.
3. The Category 6 patch cord/station cord shall meet or exceed the requirements of ANSI/TIA-568-C.2.
   a. The Category 6 patch cord/station cord color for voice shall be: Gray
   b. The Category 6 patch cord/station cord color for data shall be: Blue

2.3 FIBER PATCH CORDS / STATION CORDS

A. Multimode Fiber Patch Cords/Station Cords

1. 50/125-Micron 850nm Laser Optimized Multimode Fiber Patch Cord/Station Cord (OM3)
   a. The 50/125-micron fiber used in the multimode fiber patch cord/station cord shall have a maximum attenuation of 3.5dB/km@ 850 nm and 1.5 dB/km @1300 nm.
   b. The 50/125-micron 850nm laser optimized multimode fiber patch cord/station cord shall meet or exceed the requirements of ANSI/TIA-568-C.3.
   c. The optical fiber cord connector shall be LC.
   d. The multimode fiber patch cord assembly shall be dual zip jacketed.

B. Singlemode Fiber Patch Cords

1. 8.3/125-micron singlemode fiber patch cord:
   a. The 8.3/125-micron fiber used in the singlemode fiber patch cord shall have a maximum attenuation of 1.0 dB/km @ 1310 nm and 1.0 dB/km @ 1550 nm.
   b. The optical fiber cord connector shall have a maximum insertion loss of 0.5 dB and a reflectance of -30 dB.
   c. The 8.3/125-micron singlemode fiber patch cord/station cord shall meet or exceed the requirements of ANSI/TIA-568-C.3.
   d. The optical fiber cord connector shall be LC.
   e. The singlemode fiber patch cord assembly shall be dual zip jacketed.
   f. Angle polish connectors shall be used for video distribution.

PART 3 - EXECUTION

3.1 COPPER PATCH CORDS/STATION CORDS

A. Copper patch cords/station cords shall be installed as per the requirements specified by the manufacturer’s installation guidelines.

3.2 FIBER PATCH CORDS/STATION CORDS

A. Fiber patch cords/station cords shall be installed as per the requirements specified by the manufacturer's installation guidelines.

3.3 IDENTIFICATION

A. Refer to Section 27 05 53 - Identification for Communications Systems for labeling details.

END OF SECTION

SECTION 27 21 33

WIRELESS ACCESS POINTS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the products and execution requirements relating to Wireless Access Points requirements.

C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

D. All equipment supplied shall be listed for the purpose for which it is used and installed in accordance with any instructions included in its listing.

E. All cabling for Wireless Access Points shall be Category 6A. All cabling routed in exposed areas shall be in conduit.

F. See Section 27 15 13, “Communications Copper Horizontal Cabling,” for further detailed requirements for cabling materials and installations.

1.2 SUBMITTALS

A. Provide product data from manufacturers’ specifications.

B. See Section 27 00 00 “Communications” for additional requirements.

1.3 WORK INCLUDED

A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation.

B. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

C. The work shall include, but not be limited to the following:

1. Furnish and install all wireless access points.
2. Furnish and install all PoE switches.

1.4 PERFORMANCE REQUIREMENTS

A. Wireless Access Points (Indoor and Outdoor)

1. IEEE 802.11ac

2. Backward compatibility with legacy 802.11 clients
3. WiFi Generation 7 features
    a. Multi-Link-Operation (MLO)
    b. Preamble Puncturing
    c. 4K QAM Modulation
4. Dual-band 2.4/5GHz support, minimum
5. 1Gbps data rate, minimum
6. MIMO capability at all available bands
7. 80MHz channelization, minimum
8. Minimum peak PHY rates of
    a. 2.4GHz: 689 Mbps
    b. 5GHz: 5765 Mbps
9. IEEE 802.3at Power over Ethernet compatibility, minimum
10. IEEE 802.11ac Tx beamforming capability
11. Wall or ceiling-mountable
12. WPA2 (AES) security, minimum
13. IEEE 802.1Q RADIUS capability

B. Category 6A PoE Switches

1. IEEE 802.3at Power over Ethernet compliant, minimum
2. 208Gbps switching capacity, minimum
3. Broadcast storm control capability
4. 8GB RAM minimum
5. Auto MDI/MDI-X capability
6. 90W minimum PoE budget
7. 19” rack-mountable
8. UL-listed
9. RoHS compliant

1.5 ACCEPTABLE MANUFACTURERS

A. Indoor Wireless Access Points

1. CommScope – Ruckus Networks Series – Model R770
2. Cisco – Meraki Series
3. Aruba
4. Ubiquiti – UniFi Series
5. Or Approved Equal

B. Outdoor Wireless Access Points

1. CommScope – Ruckus Networks Series – Model T670
2. Cisco – Meraki Series
3. Aruba
4. Ubiquiti – UniFi Series
5. Or Approved Equal

C. PoE Switches

1. Cisco – Catalyst Series
2. Allied Telesis
3. HP – ProCurve Series
4. Or Approved Equal

1.6 RECORD DRAWINGS

A. Provide a complete set of Wireless Access Point manufacturer's product data and shop drawings incorporating all addenda and field changes.

B. Provide operating and maintenance manuals.

PART 2 - PRODUCTS

2.1 PRODUCT/MATERIAL DESCRIPTION

A. Wireless Access Points shall be IEEE 802.11ac compliant, capable of dual-band operation at 2.4 and 5GHz. Each Wireless Access Point location shall be cabled with two (2) Category 6A cable for full IEEE 802.11ac performance.

B. Wireless Access Points shall have the basic minimum performance characteristics noted in section 1.4, subsection A, above.

C. Power for Wireless Access Points shall be via Power over Ethernet (PoE) compliant with the IEEE 802.3at standard.

D. PoE Switches shall have IEEE 802.3at compliance, and be compatible with Category 6A cabling.

E. PoE Switches shall have the basic minimum performance characteristics noted in section 1.4, subsection B, above.

PART 3 - EXECUTION

3.1 WIRELESS ACCESS POINTS

A. Wireless access points and supporting equipment shall be installed as per the requirements specified by the manufacturers' installation guidelines and best industry practice.

B. Provide all necessary interconnections, services, and adjustments required for a complete and operable system.

C. Install control signal, communications, and data transmission line grounding as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.

3.2 FIELD QUALITY CONTROL

A. Testing

1. All devices shall be tested for full operational compliance.
2. Testing of system shall be the sole responsibility of the Contractor.

3.3 LABELING

A. Label all cables at each end of each cable. Labels shall be machine generated, wrap-around type.

B. Labeling system shall designate the cable's origin and destination on each end of each distribution/horizontal cable.

3.4 SURGE PROTECTION

A. All outdoor Wireless Access Point cabling shall have surge protection devices installed at each end that complies with manufacturer recommendations.

3.5 WARRANTY

A. All equipment, components, etc., shall be guaranteed free of defects and any faulty workmanship for a period of one year after final acceptance.

B. The Contractor shall replace defective materials and repair faulty workmanship within 24 hours of discovery at no cost to the Owner.

END OF SECTION

SECTION 27 52 26

EMERGENCY CALL SYSTEM

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.

B. This document describes the products and execution requirements relating to Emergency Call System.

C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

A. Provide product data from manufacturers' specifications.

1.3 WORK INCLUDED

A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the specification or not.

B. The work shall include, but not be limited to the following:

1. Furnish and install all central monitoring station packages (computer with second hard drive, central alarm receiver, LED monitor, UPS, software, report printer).
2. Furnish and install all controlled access and wander management modules.
3. Furnish and install all paging transmitters.
4. Furnish and install all wireless receivers.
5. Furnish and install all wireless links.
6. Furnish and install all outdoor help buttons.
7. Furnish and install all pull cord stations.
8. Furnish and install all motion detectors.
9. Furnish all personal help buttons.
10. Furnish and install all power supplies.
11. Furnish and install all batteries.
12. Furnish and install all cables.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

A. Approved Central Monitoring Station Manufacturer(s)

1. Philips – CarePoint Series

2. STANLEY Healthcare – Arial Series
3. TekTone
4. Or Approved Equal

B. Approved Controlled Access and Wander Management Module Manufacturer(s)

1. Philips – CarePoint Series
2. STANLEY Healthcare – Arial Series
3. TekTone
4. Or Approved Equal

C. Approved Paging Transmitter Manufacturer(s)

1. WaveWare Technologies
2. Or Approved Equal

D. Approved Wireless Receiver Manufacturer(s)

1. Philips – CarePoint Series
2. STANLEY Healthcare – Arial Series
3. TekTone
4. Or Approved Equal

E. Approved Wireless Link Manufacturer(s)

1. Philips – CarePoint Series
2. STANLEY Healthcare – Arial Series
3. TekTone
4. Or Approved Equal

F. Approved Outdoor Help Button Manufacturer(s)

1. Philips – CarePoint Series
2. STANLEY Healthcare – Arial Series
3. TekTone
4. Or Approved Equal

G. Approved Pull Cord Station Manufacturer(s)

1. Philips – CarePoint Series
2. STANLEY Healthcare – Arial Series
3. TekTone
4. Or Approved Equal

H. Approved Wall Mounted Motion Detector Manufacturer(s)

1. Philips – CarePoint Series
2. STANLEY Healthcare – Arial Series
3. TekTone
4. Or Approved Equal

I. Approved Ceiling Mounted Motion Detector Manufacturer(s)

1. DSC
2. Or Approved Equal

J. Approved Universal Transmitter Manufacturer(s)

1. Philips – CarePoint Series
2. STANLEY Healthcare – Arial Series
3. TekTone
4. Or Approved Equal

K. Approved Personal Help Button Manufacturer(s)

1. Philips – CarePoint Series
2. STANLEY Healthcare – Arial Series
3. TekTone
4. Or Approved Equal

L. Approved Power Supply Manufacturer(s)

1. Altronix
2. Or Approved Equal

M. Approved Battery Manufacturer(s)

1. Altronix
2. Or Approved Equal

N. RS-485 Cable (2-conductor, shielded, 24 AWG)

1. Belden
2. Or Approved Equal

O. 12/24 VDC Cable (2-conductor, unshielded, 18 AWG)

1. Belden
2. Or Approved Equal

P. 12/24 VDC Cable (2-conductor, unshielded, 16 AWG)

1. Belden
2. Or Approved Equal

PART 3 - EXECUTION

3.1 EMERGENCY CALL SYSTEM

A. The emergency call system shall be installed by a qualified contractor as per the requirements specified by the manufacturers' installation guidelines and best industry practice.

B. Provide all necessary interconnections, services, and adjustments required for a complete and operable system.

C. Install control signal, communications, and data transmission line grounding as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.

3.2 FIELD QUALITY CONTROL

A. Testing

1. All devices shall be tested for full operational compliance.
2. Testing of system shall be the sole responsibility of the Contractor.

3.3 LABELING

A. Label all cables at each end of each cable. Labels shall be machine generated, wrap-around type.

B. Labeling system shall designate the cable's origin and destination on each end of each distribution/horizontal cable.

3.4 WARRANTY

A. All equipment, components, etc., shall be guaranteed free of defects and any faulty workmanship for a period of one year after final acceptance.

B. The Contractor shall replace defective materials and repair faulty workmanship within 24 hours of discovery at no cost to the Owner.

END OF SECTION

SECTION 27 53 19

PUBLIC SAFETY DISTRIBUTED ANTENNA SYSTEM INFRASTRUCTURE

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS AND WORK INCLUDED

A. The scope of work described in these specifications and indicated on the drawings shall consist of:

1. Complete PS DAS/ERRC System Installation:
   a. Confirm applicable Public Safety Distributed Antenna System (PS DAS/ERRC) requirements with jurisdiction's Fire Marshal/Fire Code Official/Authority Having Jurisdiction (AHJ) and report requirements to Architect.
   b. Furnish and install required conduit pathways, pull string, junction boxes, and backboard spaces, with required fire-ratings and pathway survivabilities, as indicated on drawings and within applicable codes.
   c. Code-required coverage shall be met in 95% of all areas of each floor in the building. Code-required coverage shall be met in 99% of areas considered "critical" (fire command room, fire pump room, stairwells, sprinkler rooms, etc.).
   d. Backbone/feeder/riser cables utilized for connecting PS DAS/ERRC equipment shall meet pathway survivability requirements per NFPA 72 and NFPA 1225.
      1) Riser coaxial cables shall be rated as riser cables and routed through a 2-hour rated enclosure.
      2) The connection between the riser and feeder coaxial cables shall be made within the 2-hour rated enclosure, and passage of the feeder cable in and out of the 2-hour rated enclosure shall be firestopped to 2-hour ratings.
      3) Cabling and pathways utilized as part of PS DAS/ERRC systems shall meet Level 1, 2, or 3 pathway survivability requirements per NFPA 72 Chapter 24 and as defined within NFPA 72 Chapter 12.
      4) Feeder and riser cabling shall be plenum rated.
   e. Where 2-hour rated cabling is required or utilized, such cabling shall meet the following criteria:
      1) Polyolefin jacket
      2) Tinned copper braid outer conductor material
      3) Foam polyolefin/foamed CF silicon dielectric material
      4) Bare copper wire inner conductor material
      5) 50 ohm cable impedance
      6) 75.8 pF/m capacitance (23.1 pF/ft.)
      7) 1.480 ohms/km dc resistance, inner conductor
      8) 2.690 ohms/km dc resistance, outer conductor
      9) 600V dc test voltage
      10) 0.190 µH/m inductance (0.058 µH/ft)
      11) 100,000 Mohms/km insulation resistance
      12) 600V RMS jacket spark test voltage (rms)
      13) 1-8,800MHz operating frequency band
      14) 40.0kW peak power
      15) 78% velocity
      16) 20°C attenuation, ambient temperature (68°F)
      17) 40°C average power, ambient temperature (104°F)
      18) 100°C average power, inner conductor temperature (212°F)
   f. PS DAS/ERRC head end equipment shall be able to function for 12-hours, minimum, on battery backup if there is no emergency generator. Where there is an emergency generator, PS DAS/ERRC head end equipment shall be able to function for 2-hours, minimum, on battery backup. Battery backup systems shall be NEMA 3R or higher-rated cabinet.

g. PS DAS/ERRC systems, including all submittals and shop drawings related to such systems, shall require the review and approval of the jurisdiction's Fire Marshal/Fire Code Official/AHJ per IFC Section 510.5.
h. Where a donor antenna exists, isolation shall be maintained between the donor antenna and all inside antennas to not less than 20dB greater than the system gain under all operating conditions.
i. PS DAS/ERRC systems shall be engineered to minimize the near-to-far effect and include sufficient antenna density to address reduced gain conditions; exceptions are as described within IFC Section 510.
j. All signal booster components shall be contained within a NEMA 4 waterproof cabinet.
    1) Bi-Directional Amplifiers (BDA's) used in the PS DAS/ERRC systems shall have oscillation prevention circuitry.
k. PS DAS/ERRC systems shall be monitored by a listed fire alarm control unit, or where approved by the AHJ, shall sound an audible signal at a constantly-attended on-site location.
    1) Automatic supervisory signals shall include loss of normal AC power supply, system battery charger(s) failure, malfunction of the donor antenna(s), failure of active RF-emitting device(s), low-battery capacity at 70% reduction of operating capacity, failure of critical system components, the communications link between the fire alarm system and the PS DAS/ERRC system.
    2) A dedicated annunciator shall be located in the fire command room.
l. Testing as described in Part 3 of this specifications section herein.

1.2 SUMMARY

A. The installation, configuration, and testing of cable infrastructure to support in-building PS DAS/ERRC in support of and Public Safety Radio within the building. Wireless Services to be delivered are:

1. UHF
2. VHF
3. 700MHz Public Safety
4. 800MHz Public Safety

B. Spaces to be covered by PS DAS/ERRC in the building are:

1. All levels of the building, or all buildings on the property where applicable, shall be provided with coverage per code requirements.

C. Installation of amplification systems or systems that operate on or provide the means to cause interference on any PS DAS/ERRC networks shall be coordinated and approved by the AHJ.

D. A minimum signal strength of -95dBm is receivable within the building with walls, ceilings, and building skin installed.

E. A minimum signal strength of -95dBm is received by the agency's radio system when transmitted from within the building with walls, ceiling and building skin installed.

F. The inbound signal level shall be sufficient to provide not less than a Delivered Audio Quality (DAQ) of 3.0 or an equivalent Signal-to-Interference-Plus-Noise Ratio (SINR) applicable to the technology for either analog or digital signals.

G. The outbound signal level shall be sufficient to provide not less than a DAQ of 3.0 or an equivalent SINR applicable to the technology for either analog or digital signals.

SECTION 27 53 19

PUBLIC SAFETY DISTRIBUTED ANTENNA SYSTEM INFRASTRUCTURE

1.3 RELATED SECTIONS/CODES

A. IFC – International Fire Code (applicable edition per section 27 00 00)

1. Section 510 concerning Emergency Responder Radio Coverage

B. NFPA 72 – National Fire Alarm and Signaling Code (applicable edition per section 27 00 00)

1. Chapter 12 concerning requirements related to pathway survivability
2. Chapter 24 concerning requirements for Emergency Communications Systems

C. NFPA 1225 – Standard for Emergency Services Communications (applicable edition per section 27 00 00)

1. Where there is a conflict between NFPA 1225 and the IFC, the requirements of the IFC shall prevail where the IFC has been adopted as the code.

D. Applicable state fire/fire prevention codes

E. FCC – Federal Communications Commission

1. Including FCC 47 CFR Part 90.219

F. IEEE – Institute of Electrical and Electronics Engineers

G. BICSI - Building Industry Consulting Service International

H. NEC/NFPA 70 National Electrical Code and the NFPA 70E National Electrical Safety Code (applicable edition per section 27 00 00)

I. UL – (EAUED) Electrical Appliance and Utilization Equipment Director

J. American National Standard ANSI/TIA/EIA Telecommunication Building Wiring

K. All applicable Environmental Health and Safety Regulations

L. Any other applicable codes or regulations here

1.4 REFERENCES

A. The following documents shall be required during the submittal process once the ERRC/PS DAS Integrator Services Consultant/Project Manager is brought onboard:

1. iBWave ERRC/PS DAS design drawings
2. Bill of Materials
3. Project Standards Guide (PSG)

1.5 SUBMITTALS

A. Installation Contractor, hereto known as the Contractor, shall be responsible for submitting a price to provide the services as described herein. For purposes of this proposal, the following is an overview of the tasks that shall be performed by the Contractor:

1. Installation and termination of all passive cabling infrastructure including antennas and splitters per the PS DAS/ERRC design drawing details.
2. Installation of all fiber optic cabling including fusion splicing, splice enclosures, and patch panels.
3. Installation of all wall or floor mounted rack frames or enclosures.
4. Sweep testing of all coaxial cable and OTDR testing of all fiber cabling.
5. System tested and certified by a GROL (General Radio Operator License) Engineer.
6. Completion and submittal of all documents listed in section 1.4, subsection A as noted above.

B. The Contractor shall be responsible for all fees or permits. This includes, but is not limited to:

1. Above ceiling permits
2. Ceiling or floor penetration permits
3. Owner-required work area permits
4. Local permits where applicable and associated fees.

C. All materials shall be provided by the ERRC/PS DAS Integrator with the exception of cable support hardware, grounding cable and lugs, cinder block ballast, ladders, lifts, and general installation tools.

D. Contractor shall be available during the commissioning phase of the project to assist in the remediation of infrastructure-related issues.

E. Upon award of the contract, the Contractor is to provide the following:

1. The executed subcontract agreement
2. Valid insurance certificate
3. W-9

1.6 QUALITY ASSURANCE

A. Upon acceptance of the contract, the Contractor shall comply with all requirements herein and has read in detail and accepts the project standards as set forth in the PSG.

B. Contractor must allot time for a mandatory 2-hour project kick-off and installation standards training session if required.

C. Contractor shall have a minimum of five years full-time experience executing work of similar scope and complexity.

D. Contract shall provide installation personnel trained in the proper installation and termination of passive PS DAS/ERRC components and cabling.

E. Contractor shall provide technical personnel trained in the proper use of testing equipment to be utilized for all coaxial cable and fiber optic cabling. All test equipment shall be properly calibrated prior to use.

F. Contractor shall provide personnel trained in the proper processes and procedures related to single mode fiber fusion splicing.

1.7 DELIVERY, STORAGE AND HANDLING

A. The Contractor shall receive all equipment at their local warehouse or at the jobsite if coordinated with the Owner.

B. The ERRC/PS DAS Integrator Project Manager shall forward copies of the original purchase orders to the Contractor for cross-referencing upon receipt of the actual hardware.

C. The contractor shall at that time of delivery capture the serial numbers of all active equipment and denote those numbers on the packing list as provided by the ERRC/PS DAS Integrator Project Manager for documentation purposes at a later date.

1. This does not apply to passive equipment such as cable, antennas, termination hardware, etc.

D. All packing slips are to be forwarded back to the ERRC/PS DAS Integrator Project Manager electronically when completed.

E. The Contractor is responsible to report any discrepancies or visibly damaged shipments to the ERRC/PS DAS Integrator Project Manager.

F. The security of the inventory is the Contractor's responsibility and as such the Contractor shall be responsible for replacing all missing hardware upon proof of delivery by the ERRC/PS DAS Integrator.

G. Upon completion of the project, the Contractor shall ship all remaining hardware to the ERRC/PS DAS Integrator with an associated packing list.

PART 2 - PRODUCTS AND SERVICES

2.1 MANUFACTURERS

A. PS DAS/ERRC Omni-Directional Repeater Antenna Manufacturer(s)

1. CommScope – Cellmax series
2. Advanced RF Technologies
3. Comba
4. Cushcraft
5. Andrew
6. Galtronics
7. Or Approved equal.

B. PS DAS/ERRC Donor Antenna Manufacturer(s)

1. Amphenol Procom
2. Wilson
3. Or Approved equal.

C. PS DAS/ERRC Head End/Bi-Directional Amplifier (BDA) and Battery Backup Manufacturer(s)

1. Honeywell – Notifier Series
2. Westell
3. Comba
4. Advanced RF Technologies
5. Sema Wireless Service, LLC
6. Or Approved equal.

D. PS DAS/ERRC Backbone/Feeder/Riser 2-Hour Fire-Rated 1/2" Coaxial Cable Manufacturer(s)

1. American Fire Wire – Model AFW-2HFR-3

E. PS DAS/ERRC Horizontal 1/2" Plenum-Rated Heliax Coaxial Cable Manufacturer(s)

1. CommScope
2. Trilogy Communications – AirCell Series
3. Or Approved Equal

F. PS DAS/ERRC Coaxial Connector Manufacturer(s)

1. CommScope
2. Or Approved Equal

G. PS DAS/ERRC Coaxial Splitter Manufacturer(s)

1. MicroLab
2. Westell
3. Or Approved Equal

H. PS DAS/ERRC Coaxial Jumper Cable Manufacturer(s)

1. CommScope
2. Or Approved Equal

I. PS DAS/ERRC Coaxial RF Surge Suppressor Manufacturer(s)

1. PolyPhaser
2. Or Approved Equal

J. Or Approved Equal PS DAS/ERRC Fiber Optic Cable Manufacturer(s)

1. Corning
2. Or Approved Equal

K. Coordinate approved manufacturer(s) and requirements for BDA's, battery backup, NEMA-rated enclosures, etc. with the PS DAS/ERRC Integrator Project Manager.

L. All other PS DAS/ERRC passive hardware shall be various manufacturers; coordinate with the ERRC/PS DAS Integrator Project Manager for all other approved manufacturers and part numbers. All materials and installation shall be provided by the Division 27 Contractor. Final system configuration and testing shall be by the PS DAS/ERRC services consultant.

2.2 MATERIALS

A. All materials shall be provided by the ERRC/PS DAS Integrator with the exception of cabling support hardware, labels or labeling devices, fire stop material, ground cable and lugs, test equipment, general installation tools, and ladders or lifts which shall be provided by the Contractor.

2.3 MATERIALS AND SERVICES CONSULTANT

A. The Division 27 Contractor shall contact the ERRC/PS DAS Integrator Project Manager to coordinate all of the materials and services required for this project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The Contractor is responsible for examining all documents as identified in Section 1.03. All questions should be directed to the ERRC/PS DAS Integrator Project Manager.

3.2 IN-BUILDING CABLE INSTALLATION STANDARDS

A. All cable shall be supported at intervals of no more than 6 feet.

B. The Contractor is responsible for installing any and all specialized support hardware necessary to comply with cabling support standards. Plenum rated tie wraps may be used for securing cable bundles above false ceilings or in trays.

C. If cable tray is not available, D-rings, Bridal Rings with Saddles, or J-Hooks are the only acceptable cabling support methods.

D. The use of tie wraps for cable bundles in closets or exposed areas is prohibited. The use of Velcro or wax string lacing is the only acceptable method.

E. All fiber connections shall be fusion spliced. Dust caps shall be used on all open fiber bulkheads and connectors at all times.

F. Under no circumstances shall cabling be supported by or left resting on ceiling tiles or grids. Attachment to existing conduits, drop ceiling supports, or sprinkler pipes is strictly forbidden.

G. The Contractor is responsible for firestopping and patching all wall or floor penetrations performed during the project.

H. The bend radius of the cabling shall be no less than 10 times the radius of the cable. e.g.: cable with a ½ diameter x 10 = 5" bend radius.

I. The use of existing cable pathways shall be coordinated by the Contractor with the Owner prior to utilization. Any significant cable pathway variances must be redlined on the PS DAS/ERRC design drawings.

J. Noncompliance with the aforementioned sections shall result in corrective actions at the Contractor’s expense.

3.3 PASSIVE INDOOR HARDWARE

A. Air Dielectric ½" plenum indoor cable shall be installed by the Contractor as indicated on the PS DAS/ERRC design drawings.

B. Contractor shall install twelve strand single mode armored fiber between the head end and the remote closets. The fiber shall be fusion spliced using pigtails into properly sized fiber enclosures.

C. Indoor antennas shall be installed in a homerun configuration back to the designated telco closet as detailed on the PS DAS/ERRC design drawings. This shall also include directional antennas and any antennas requiring a ground plane.

D. All omni-directional ceiling antennas shall be installed with a 3 ft. service loop in place to accommodate antennas that may need to be relocated slightly.

E. All splitters, combiners, and couplers shall be installed by the Contractor as indicated on the PS DAS/ERRC design drawings in the associated telecom rooms and head-end location unless otherwise indicated on the PS DAS/ERRC design drawings. All splitters, couplers, and combiners are to be secured to a backboard or other surface. Unsecured inline installation is not acceptable if a proper mounting surface is available.

F. The Contractor shall install floor or wall mounted racks as indicated in the T-series Telecom drawings and PS DAS/ERRC design drawings.

3.4 LABELING

A. Unless otherwise indicated here, all labeling and tagging shall conform to the numbering scheme as indicated on the PS DAS/ERRC design drawings and the PSG.

3.5 BILL OF MATERIALS

A. A bill of materials shall be provided by the Contractor for review. All materials shall be provided by the Division 27 Contractor purchased through the ERRC/PS DAS Integrator Project Manager.

3.6 TESTING

A. Testing shall be required per IFC Section 510.6.

B. Cable Sweeps shall be performed using an Anritsu or equal test device. The device shall be calibrated using a 50 ohm load prior to testing.

C. Testing shall be performed on the cable between the splitter to the antenna connection end of the cable. Testing from the splitter end to an installed antenna without the 50 ohm load in place is unacceptable. All cables must be tested prior to final connection to the splitters or antennas.

D. Cables shall be tested for Distance to Fault, Shorts, or Opens. If these anomalies are detected, they are to be corrected and retested. The submittal of failed tests will result in corrections to be performed at the contractor’s expense.

E. Unless otherwise noted, tests shall be performed at 1900MHz. Test results are to be submitted in the native format of the test device and a common format. The acceptable common formats are either jpg. or PDF.

F. Continuous Wave (CW) testing shall be performed by the ERRC/PS DAS Integrator.

G. Fiber between the remote locations and Head End shall be tested using an OTDR at 1300nm and 1550nm bi-directionally. Electronic versions of the test results in PDF format are to be provided to the ERRC/PS

DAS Integrator Project Manager upon completion and before system commissioning. Any issues noted during the testing are to be identified, corrected, and re-tested. Any cable found to be damaged during testing due to poor installation standards shall be replaced at the Contractor's expense.

3.7 DOCUMENTATION

A. The Contractor shall submit the following to the ERRC/PS DAS Integrator Project Manager:

1. Redline drawings with any location or cable pathway variances.
2. Photographs of all equipment installations and grounding in the main and remote closet locations.
3. Photographs of all outdoor antennas, antenna supports, cabling supports and connector protection, including mast and cable grounding.
4. Fiber optic test results in the native program file and PDF format.
5. Cable sweep test screen shots in jpg or PDF format.

END OF SECTION

SECTION 27 70 10

SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. These specifications describe the electrical and mechanical requirements for a hybrid, high energy, suppression filter system that integrates Surge Protective Devices (SPDs) with high frequency electrical line noise filtering for high exposure applications.

B. The specified unit(s) shall provide effective high energy transient voltage suppression, surge current diversion, and noise attenuation for all electrical modes of equipment connected downstream from a facility's meter or main over current device in high exposure ANSI/IEEE C62.41category C, B or A environments.

C. The unit shall be designed and manufactured by a qualified manufacturer of surge suppression equipment. The qualified manufacturer shall have been engaged in the commercial design and manufacture of such products for a minimum of ten (10) years. These specifications are based on DITEK Surge Protective Devices (SPDs). For consideration, other manufacturers shall provide detailed compliance or exception statements to all provisions of this specification fifteen (15) days prior to bid.

1.2 STANDARDS

A. The specified unit shall be designed, manufactured, tested and installed in compliance with the following standards:

1. ANSI/IEEE C62.33 Standard Test Specifications for Varistor Protection Devices
2. ANSI/IEEE C62.35 Standard Test Specifications for Avalanche Semiconductor Protection Devices
3. ANSI/IEEE C62.41.1 IEEE Guide on the Surge Environment in Low-Voltage (1000V and Less) AC Power Circuits
4. ANSI/IEEE C62.42.2 IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
5. ANSI/IEEE C62.45 IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits
6. UL -1283 Standard for Safety - Electromagnetic Interference Filters
7. UL -1449, Standard for Safety - Surge Protective Devices
8. NFPA 70 National Electrical Code
9. NFPA 75 Standard for the Protection of Electronic Computer Systems
10. NFPA 780 Standard for the Installation of Lightning Protection Systems
11. Military Standard (Mil Std) 220A Federal Information Processing Standards Publication 94 (FIPS PUB 94)CCITT
12. National Electrical Manufacturers Association;(NEMA LS1-1992 Guidelines) Low Voltage Surge Protective Devices

1.3 ENVIRONMENTAL REQUIREMENTS

A. Storage Temperature

1. Storage temperature range shall be -40° to +85° C (-40° to +185° F).
2. Internally mounted devices may be 0° to 40° C (32° to +104° F).

B. Operating Temperature

1. Operating temperature range shall be -40° to +60° C (-40° to +140° F).
2. Internally mounted devices may be 0° to 40° C (32° to +104° F).

C. Relative Humidity

1. Unit shall be operable within 0% to 95% non-condensing relative humidity.

D. Operating Altitude

1. The unit shall be capable of operation in altitudes up to 12,000 feet (3,658 meters) above sea level.

E. Audible Noise

1. The unit shall not generate any audible noise.

F. Magnetic Fields

1. No appreciable magnetic fields shall be generated. Unit shall be capable of use directly in computer rooms in any location without danger to data storage systems or devices.

1.4 SYSTEM DESCRIPTION

A. Surge Protective Devices (SPDs) are the equipment required for the suppression, within specified limits, of AC electrical circuits and electronic equipment from the effects of lightning induced voltages, external switching transients and internally generated switching transients. Individual suppressors shall be installed as indicated on drawings.

1.5 OPERATING VOLTAGE

A. The nominal operating voltage and configuration shall be as indicated on the drawings

1.6 SUBMITTALS

A. Submit in accordance with Section 16XXX, Basic Electrical Requirements.

B. Submit installation details for all suppressors demonstrating mechanical and electrical connections to equipment being protected.

C. Submittals shall include, but are not limited to, the following data:

1. Complete data for each suppressor type indicating conductor sizes, circuit type, operating voltage, and all appropriate dimensions.
2. Dimensions for each suppressor type indicating mounting dimensions and required accessory hardware.
3. Drawings shall be provided indicating suppressor mounting, lead configuration and mounting of remote diagnostic equipment and assemblies (where applicable).
4. List and detail all protection systems such as fuses, disconnecting and protective materials.

5. Listing to UL 1449, including voltage protection rating, nominal discharge current and short circuit current rating for each SPD specified.
6. Conformance to appropriate referenced standards and publications listed in section 1.02.
7. The submittal shall include a listed comparison and proof of compliance with each paragraph of these specifications.

D. Submitted suppressors shall have specifications equal to or better than the characteristics specified herein.

1.7 QUALITY ASSURANCE

A. Surge suppression, along with proper grounding and bonding, shall effectively protect within tested limits. This is protection against lightning transients, internal and external switching transients, and other surge transients throughout the useful life of the system.

B. Any SPD which shows evidence of defects in materials or workmanship during the warranty period shall be replaced or repaired at the Manufacturer's discretion.

C. Installation of an SPD in or on electrical or electronic systems shall in no way compromise or violate equipment listing, function or warranty of the distribution equipment.

D. All SPDs shall be guaranteed by the installing contractor to be free of defects in material and workmanship for a period of ten (10) years from the date of manufacture.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in surge suppression equipment of the type herein specified with a minimum of ten (10) years documented experience.

B. Installer: Installation shall be by a duly licensed and trained electrical contractor.

1.9 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on shop drawings.

1.10 COORDINATION

A. Coordinate work with electrical installations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The intent of this specification is to allow manufacturers with similar equipment utilizing metal oxide varistor (MOV) technology to provide transient voltage surge suppression within the guidelines set forth herein.

B. The SPD manufacturer shall offer factory service and replacement for all units, within warranty guidelines. The manufacturer shall provide this service within a reasonable time frame.

C. Single source of supply. All AC power SPD's shall be manufactured by a single manufacturer.

1. Acceptable manufacturer:
   a. DITEK Corp

2. The following products are recommended for main distribution panel applications:
   a. D200 Series

3. The following products are recommended for distribution or sub-panels:
   a. D200 Series
   b. D100 Series
   c. D50 Series

4. All electronics, voice/data, video surveillance, access control, or fire system suppressors shall be manufactured by a single manufacturer. Acceptable manufacturer: DITEK Corp., models as further identified herein for each individual system specification. Manufacturers listed herein have demonstrated that they can provide equipment that meets or exceeds all requirements, however other manufacturers demonstrating compliance of specifications contained herein will also be considered.

2.2 COMPONENTS

A. Main service and distribution equipment suppressors: AC voltage SPDs shall be high speed, high current devices designed to protect electrical systems and electronic equipment from transient over-voltage events. SPDs shall provide continuous protection, and automatically reset. The SPD shall utilize Thermally Protected Metal Oxide Varistor TP-MOV™ technology. The SPD shall be installed in parallel with the service main disconnect, distribution or branch panel main lugs as applicable. SPDs shall be connected to overcurrent protection sized as indicated in installation instructions, with an AIC rating equal to or greater than panel rating. The suppressor shall have status indicator light(s). Dry contacts with remote alarm capabilities, audible alarm, and a surge counter are optional equipment.

1. Electrical Service
   a. Voltage shall be as indicated on drawings.
   b. Frequency -- 50/60 Hz
   c. Phases -- shall be as indicated on drawings.
   d. Wiring configuration – shall be as indicated on drawings

2. IEEE 62.41 Location Categories unless otherwise indicated on drawings:

Location Category		**Low**	**Medium**	**High**
Service Entrance/Outbuilding/Meter	C	C1	C2	C3
Sub-Panel/ Distribution Panel	B	B1	B2	B3
Outlets/Long Branch Circuits	A	A1	A2	A3

3. Electrical Performance
   a. Response time < 50 nanoseconds
   b. MCOV 125% minimum.

4. Minimum Surge Current:
   a. Service Entrance 00,000 Amps/Phase Minimum

b. Distribution and Sub-panels 50,000 Amps/Phase Minimum

5. Suppression system protected modes shall be L-N, L-G, N-G, and L-L for Wye Systems L-L, and L-G for Delta systems. Ungrounded Delta Systems shall be L-L.
6. Power on indicators and failure detection: Light Emitting Diodes (LEDs) on the cover shall provide indication that the suppressor is properly activated and shall also indicate mode failure. If the suppressor fails, an isolated contact shall close. In addition, an audible alarm may be provided with manual reset, for those so equipped.

B. Enclosures: Enclosures for main service suppressors shall be, at a minimum, NEMA 3R/12.

C. Operation Status Indicator: Audible Remote Signaling and Visual Systems

1. Visual System
   a. Protection: Suppressor Functioning Normally – Green LED(s) on.
   b. Warning/Fault: Suppressor Failure – Green LED(s) off.
   c. Other visual indicators where approved.

2. Remote Signaling
   a. For units that are so equipped, relay with Auxiliary for Form C (dry) relay contacts: Two sets @ 1 Ampere, 120 volts each. 1 set N.O. and 1 set N.C. to operate upon failure of suppression module, blown fuse or tripped circuit breaker in suppressor module, AC power loss, or in disconnect switch for alarm connection to remote location.

3. Audible
   a. For units that are so equipped, the audible alarm shall activate upon a fault condition within the suppressor. An alarm silence/reset switch and push-to test switch shall be provided.

D. Communication Lines:

1. The following standard for separately mounted telephone and signal line suppressors shall apply. All protectors shall be securely mounted at protected equipment location. All suppressors shall provide common (L-G) mode protection on all lines. Suppressors shall be tested in accordance with IEEE C62.36 as a minimum. Protective interfacing with the telephone wire pairs shall be listed to UL 497A.

E. Network Data Protection:

1. Solid state, silicon avalanche diode components shall be the main protection technology utilized. Interfaces shall be RJ45, or 110 punch block connectors. The SPDs shall have a verified data transmission rate, without attenuation, of Category 6 speed minimum. The maximum clamp voltage of the SPD shall be no greater than 18 Volts on a 5 Volt circuit.

F. Power Over Ethernet (PoE) / Voice over Internet Protocol (VoIP) Protection:

1. Solid state, silicon avalanche diode components shall be the main protection technology utilized. RJ45 modular jacks shall be the connection method used. Connector pinouts shall conform to IEEE 802.3af for power distribution pairs and data transmission pairs. The maximum clamp voltage of the SPD on the power transmission pairs shall be no higher than 72 Volts. The maximum clamp voltage of the data transmission pairs shall be no higher than 72 Volts. The SPD shall have a verified data transmission rate, without attenuation, of Category 6 speed minimum.

G. Data Line Protection:

1. Solid state, silicon avalanche diode circuitry for protection from over voltages on long cable runs employing standard RS-232, RS422, or RS485. Appropriate connectors shall be utilized to interface a remote station with a host CPU.

H. Signal Line Protection:

1. Solid state, silicon avalanche diode, metal oxide varistor, and/or gas discharge tube technologies may be used. Hybrid circuitry for protection from over voltages on 2 or 4 wire signal lines such as balanced pair telephone, metallic pair telephone, buried and overhead field cable, remote radio equipment, and control systems. Unit shall be listed UL497B.

I. Modular, Twisted Pair Protection:

1. Solid state, silicon avalanche diode or metal oxide varistor circuitry for protection from over voltages on twisted pair data or audio lines. Protectors shall clip mount on 66 punch down blocks furnished with grounding bar or studs and shall be totally enclosed. Units shall be securely mounted at terminal locations where shown and shall be grounded to the main building ground with a minimum No.12 stranded copper green insulated ground conductor kept as short as possible. Ground terminals shall be screw insertion lug type. No crimp, fork or ring type permitted.

J. Coaxial Cable Protectors:

1. Solid state, silicon avalanche diode, metal oxide varistor and/or gas tube circuitry for non-interrupting over voltage protection of coaxial cable. Unit shall be provided with one female input connector and one female output connector. Securely mount adjacent to protection equipment and ground to equipment or local building ground.

2.3 SYSTEM EQUIPMENT SPECIFICATIONS

A. Telephone and Intercom Systems

1. Suppressors shall be installed on the AC power at the point of service and shall meet the following criteria:
   a. UL 1449 Listed
   b. UL 1449 V.P.R. of 500 Volts or lower
   c. Diagnostic Indicator Light(s)
   d. Integrated ground terminating post (where case/chassis ground exists)
   e. Minimum Surge Current Capacity of 36,000 Amps (8 x 20 µSec)
   f. Ten Year Limited Warranty
   g. Acceptable Manufacturer:
      1) DITEK CORP. (800-753-2345) – DTK- 3GTP, or approved equal.

2. Suppressors shall be installed on incoming central office lines and shall meet the following criteria:
   a. UL 497A Listed
   b. Multi Stage protection design
   c. Auto-reset current protection with current limiting not to exceed 150mA per line
   d. Minimum Surge Current of 1,000 Amps per pair (8 x 20 µSec) 5.Ten Year Limited Warranty
   e. Acceptable Manufacturer:
      1) DITEK CORP. (800-753-2345) – DTK-SL Series or approved equal.

3. Suppressors shall be installed on all telephone/intercom circuits that enter or leave separate buildings and shall meet the following criteria:

a. UL 497A Listed (where applicable)
b. UL 497B Listed (speakers or communication circuits)
c. Multi Stage protection design
d. Auto-reset over-current protection with current limiting not to exceed 150mA per line -UL 497A units
e. Over-current protection not to exceed 5 Amps per pair-UL497B units
f. Minimum Surge Current of 1000 Amps per pair (8 x 20 µSec)
g. Ten Year Limited Warranty
h. Acceptable Manufacturer:
    1) DITEK CORP. (800-753-2345)
        a) DTK-SL Series
        b) DTK-2MHLP/2MHTP Series
        c) DTK-LVLP Series, or approved equal.

B. Fire Alarm Systems – Engineering Documentation – Fire Alarm Surge Specification

1. Line Voltage Surge Protective Devices
    a. Line voltage surge protective devices (SPDs) shall be provided to suppress all voltage transients which might damage fire alarm panel components. The surge protection device shall wire in series to the power supply of the protected equipment. Line voltage surge protection device shall be installed directly adjacent to FACP.

2. Nominal 120 Volt Surge Protective Device
    a. SPDs for nominal 120 volt supply voltage shall be UL 1449 Third Edition listed or recognized with a minimum peak surge current of 54,000 amps. The SPD shall also meet IEEE C62.41 category B tests for surge capacity. The SPD shall feature multi- stage construction and be provided with dry contacts for monitoring and a long life indicator lamp for unit status of protected components.

3. Nominal 24 Volt Surge Protective Device
    a. SPDs for nominal 24 volt circuits shall be UL 497B listed and with a minimum surge rating of 20,000 amps. The SPD shall feature multi-stage construction and be self- resetting. Surge protective device shall be a base & plug style. The base assembly shall have screw terminals for fire alarm circuits. Base assembly shall accept a replaceable "plug in" surge protection module.

4. Alarm Dialer / Networking Surge Protective Device
    a. SPDs for alarm telephone dialer circuits shall be UL 497A listed. The SPD shall feature multi-stage construction and be self-resetting. Surge protective device shall be RJ connections or base & plug style. The base assembly shall have screw terminals for fire alarm dialer circuits. Base assembly shall accept a replaceable "plug in" surge protection module.

5. Acceptable Manufacturers
    a. All Surge Protective Devices (SPDs) shall be the standard product of a single manufacturer and be equal or better than one of the following:
        1) For 120 Volt nominal line voltage, DITEK DTK-120SRD series-connected, Dry Contact for remote notification of sacrifice ,20A AC power SPD;
        2) For 24 Volt nominal voltage, DITEK DTK-2MHLP24BWB series-connected, modular, 5A maximum current SPD.
        3) For alarm telephone dialers, DITEK DTK-2MHTPWB series-connected, modular SPD or RJ31X style, DITEK DTK-MRJ31XSCPWP
        4) For Ethernet networked systems DITEK DTK-MRJ45C5E, modular RJ45 style SPD.
        5) For Wireless GSM, DITEK DTK-VSPN

6) For an all-inclusive surge solution using the above components, DTK-TSS1, DTK-TSS2, DTK-TSS3 and DTK-TSS4D.
7) Acceptable Manufacturer: DITEK CORP. (800-753-2345)

C. Energy Management and Control Systems (EMCS)

1. Suppressors shall be installed on the incoming AC EMCS Panel and shall meet the following criteria:
   a. Parallel connected
   b. Suppression between L-N, L-G, N-G and L-L
   c. Surge Current Capacity: 32,500 Amps (8 x 20 µSec)
   d. Ten Year Limited Warranty
   e. Acceptable Manufacturer: DITEK CORP. (800-753-2345)
      1) DTK-120/240HW, or approved equal.

D. Suppressors shall be installed on all EMCS LV circuits on points of entry and exit from separate buildings. Suppressors shall meet the following criteria:

1. UL 497B Listed
2. Multi-stage protection design.
3. Fail-short/fail-safe mode.
4. Minimum Surge Capacity: 2,000 Amps per pair (8x20 µSec)
5. System Voltage: 12 Vrms or 24Vrms
6. Ten Year Limited Warranty
7. Acceptable Manufacturer: DITEK CORP. (800-753-2345)
   a. DTK-2MHLP Series
   b. DTK-TSS3
   c. DTK-LVLP Series, or approved equal.

E. Security Systems (Intrusion Detection)

1. Suppressors shall be installed on AC at the point of service and shall meet the following criteria:
   a. UL 1449 Listed
   b. UL 1449 V.P.R. of 500 Volts or lower
   c. Status Indicator Light(s)
   d. Center screw for terminating Class II transformers
   e. Minimum Surge Current Capacity of 32,000 Amps (8 x 20 µSec)
   f. Ten Year Limited Warranty
   g. Acceptable Manufacturer: DITEK CORP. (800-753-2345)
      1) DTK-1F or approved equal.

F. Suppressors shall be installed on all Telephone Communication Interface circuits and shall meet the following criteria:

1. UL 497A Listed
2. Multi Stage protection design
3. Surge Current Capacity: 9,000 Amps(8x20 µSec)
4. Clamp Voltage: 180VDC, +/- 10%
5. Auto reset current protection with current limiting not to exceed 150mA
6. Ten Year Limited Warranty
7. Acceptable Manufacturer: DITEK CORP. (800-753-2345)
   a. DTK- MRJ31XSCPWP, or approved equal.

G. Suppressors shall be installed on all burglar alarm initiating circuits, and signaling circuits which enter or leave separate buildings. The following criteria shall be met:

1. UL 497B for data communications or annunciation (powered loops)
2. Fail-short/fail-safe mode.
3. Surge Current Capacity: 20,000 Amp (8x20 µSec)
4. Ten Year Limited Warranty
5. Acceptable Manufacturer: DITEK CORP. (800-753-2345)
    a. DTK-2MHLP_ _B Series and DTK-MB10 base

2.4 COMPUTER / DATA SYSTEM

A. Suppressors shall be installed on AC power at the point of service and shall meet the following criteria:

1. UL 1449 Listed
2. UL 1449 V.P.R. of 400 Volts or lower
3. Status Indicator LED(s)
4. 12 Amp circuit breaker (rack mount) or 15 Amp circuit breaker (wall or desktop)
5. Minimum Surge Current Capacity of 36,000 Amps (8 x 20 µSec)
6. Minimum of 6 foot cord
7. Ten Year Limited Warranty
8. Acceptable Manufacturer: DITEK CORP. (800-753-2345)
    a. DTK-8FF
    b. DTK-RMAC12, or approved equal.

B. Suppressors shall be installed on all computer/data circuits on points of entry and exit from separate buildings and shall meet the following criteria:

1. All pins must be protected
2. Must be Category 6 minimum, Gigabit Ethernet
3. Connection method: RJ45 (8-pin) or 110 Block.
4. Surge Current Capacity: Minimum 30 Amps per pair (8x20 µSec)
5. Ten Year Limited Warranty
6. Acceptable Manufacturer: DITEK CORP. (800-753-2345)
    a. DTK-MRJ45C5E (single device)
    b. DTK-MRJPOE (single device)
    c. DTK-RM12C5RJ (12-port, RJ45, 1U rack mount, or approved equal)
    d. DTK-RM12POE (12-port, RJ45, 1U rack mount, or approved equal)

2.5 VIDEO SURVEILLANCE

A. Protectors shall be installed on coaxial cable systems on points of entry and exit from separate buildings. Suppressors shall be installed at each exterior camera location and shall include protection for 12 and/or 24 volt power, data signal and motor controls (for Pan, Tilt and Zoom systems). SPDs shall protect all modes herein mentioned and shall contain all modes in a single unit system. Protection for all systems mentioned above shall be incorporated at the head end equipment. Additionally a minimum 600VA battery back up shall be used to protect the DVR or VCR and monitor. Protectors shall meet the following criteria:

1. Head-End Power
    a. Battery Back Up

b. Minimum Surge Current Capacity: 65,000 Amps (8x20µsec)
c. Minimum of 2 NEMA 5-15R Receptacles (1 AC power only, 1 with UPS)
d. All modes protected (L-N, L-G, N-G)
e. EMI/RFI Filtering
f. Maximum Continuous Current: 12 Amps
g. Ten Year Limited Warranty
h. Acceptable Manufacturer: DITEK CORP. (800-753-2345)
    1) DTK-DRP16
    2) DTK-BU600PLUS, or approved equal.

2. Camera Power
    a. Minimum Surge Current Capacity: 2,000 Amps (8X20µsec); 30 Amps per pair for IP Video/PoE cameras
    b. Screw Terminal Connection
    c. All protection modes L-G (all Lines)
    d. Ten Year Limited Warranty
    e. Acceptable Manufacturer: DITEK CORP. (800-753-2345)
        1) DTK-DP4P Series (PTZ Cameras)
        2) DTK-PVP Series (Fixed Cameras)
        3) DTK-RM12POE (12 port, 1U rack mount Power over Ethernet)
        4) DTK-MRJPOE (Single camera Power Over Ethernet), or approved equal.

3. Video and Data
    a. Minimum Surge Current Capacity 114 Amps per pair-Analog; 30 Amps per pair-IP Video/PoE Cameras
    b. “BNC” Connection (Coax); RJ45 IP Video/PoE Cameras
    c. Protection modes: L-G (Data), Center Pin-G, Shield-G (Coax)
    d. Minimum Band Pass 0-10MHz
    e. Ten Year Limited Warranty
    f. Acceptable Manufacturer: DITEK CORP. (800-753-2345)
        1) DTK-DRP16 (Head End)
        2) DTK-RM16NM (16 channel, 1U rack mount)
        3) DTK-DP4P Series (PTZ Camera)
        4) DTK-PVP Series (Fixed Camera)
        5) DTK-iBNC28 (Coax video only)
        6) DTK-PVPIP (Single camera video, data and power)
        7) DTK-RM12C5RJ (12 port, 1U rack mount mount)
        8) DTK-RM12POE (12 port, 1U rack mount Power over Ethernet)
        9) DTK-MRJPOE (Single camera Power Over Ethernet), or approved Equal

2.6 CABLE TELEVISION SYSTEMS

A. Suppressors shall be installed at the point of AC service to the head end equipment and meet the following criteria:

1. Minimum Surge Current Capacity: 27,000 Amps (8 x 20 µSec)
2. All mode protection: L-N, L-G, N-G
3. EMI/RFI Filtering
4. UL 1449 Listed
5. UL V.P.R. of 500 Volts or less
6. Diagnostic Indicator Light(s)
7. Ten Year Limited Warranty
8. Acceptable Manufacturer: DITEK CORP. (800-753-2345)

a. DTK-1F
b. DTK-8FF, or approved equal

B. Suppressors shall be installed on all coaxial cable systems on points of entry and exit from separate buildings. Suppressors shall be installed at each exterior camera location and shall meet the following criteria:

1. Impedance: Match the existing system being protected (75 Ohm).
2. Band pass: 0 - 2GHz
3. Surge Current Capacity: At least 20 kA (8 x 20 µSec waveform)
4. Clamping Voltage: 75VDC Center Pin to shield
5. Response Time: Less than one nanosecond.
6. Acceptable Manufacturer: DITEK CORP. (800-753-2345)
   a. DTK-VSPA
   b. DTK-VSPA2 or approved equal.

2.7 ACCESS CONTROL SYSTEMS

A. Suppressors shall be installed on AC power at the point of service and shall meet the following criteria:

1. UL1449 3rd Edition Listed
2. UL1449 V.P.R. of 500 Volts or lower
3. Status Indicator Light(s)
4. Minimum Surge Current Capacity: 144,000 Amps (8 x 20 µsec)
5. Maximum Continuous Current: 15 Amps
6. MCOV: 125VAC
7. Service Voltage: 110-120 VAC
8. Ten Year Limited Warranty
9. Acceptable Manufacturer: DITEK CORP. (800-753-2345)
   a. DTK-8FF or approved equal.

B. Suppressors shall be installed on the Burg/Fire Low Voltage circuit at both the point of entrance and exit of the building. Suppressors shall meet the following criteria:

1. UL 497B
2. Minimum Surge Current Capacity: 2,000 Amps per pair
3. Maximum Continuous Current: 5 Amps
4. MCOV: 33 Volts
5. Service Voltage: 24Volts
6. Ten Year Limited Warranty
7. Acceptable Manufacturer – DITEK CORP. (800-753-2345)
   a. DTK-2MHLP24BWB
   b. DTK-1LVLPLV or approved equal.

C. Suppressors shall be installed on the communication circuit between the access controller and card reader at both the entrance and exit of the building. Suppressors shall meet the following criteria:

1. Conforms with UL497B standard (where applicable)
2. Clamp level for 12 and 24V power: 18VDC / 38VDC
3. Clamp level for Data/LED: 6.8VDC
4. Service Voltage for Power: 12VDC/24VDC
5. Service Voltage for Data/LED: <5VDC

6. Clamp level – PoE Access Power: 72V
7. Clamp level – PoE Access Data: 72V
8. Service Voltage – PoE Access: 48V-54V
9. Service Voltage – PoE Data: 5V-24V
10. Ten Year Limited Warranty
11. Acceptable Manufacturer – DITEK CORP. (800-753-2345)
    a. DTK-4LVLPCR (use DTK-3LVLP-X for "Wiegand" type readers)
    b. DTK-4LVTEP (commercial telephone entry)
    c. DTK-4LVXR (residential telephone entry)
    d. DTK-MRJPOE (Power over Ethernet access control), or approved equal.

2.8 ELECTRONIC EQUIPMENT

A. Suppressors shall be installed at the point of AC service to the electronic equipment and meet the following criteria:

1. UL1449 Listed
2. Must have 3 AC outlets capable of handling 15 Amps.
3. Minimum Surge Current Capacity: 36,000 Amps (8 x 20 µSec)
4. All mode protection: L-N, L-G, N-G
5. EMI/RFI Filtering
6. Diagnostic Indicator Light(s)
7. Ten Year Limited Warranty
8. Acceptable Manufacturer: DITEK CORP. (800-753-2345)
    a. DTK-3GTP or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Main Service and Distribution Equipment Surge Suppressors

1. Suppressors shall be installed at Service Entrance switchboards and distribution equipment where shown as close as practical to equipment to be protected consistent with the available space. Where installation space permits and where no code restrictions apply, suppressors may be installed within protected equipment. Suppressors installed in this manner shall utilize the equipment ground bus as a medium for bonding of their ground terminals. Bolted connections with star washers shall be used to insure electrical and mechanical integrity of connections to the ground bus. Conductors from suppressors shall attach to main service bus in the entrance equipment on the load side of any electrical metering equipment.
2. Suppressors shall be installed according to manufacturer instructions provided with each device. Lead dress shall be consistent with recommended industry practices for the system on which these devices are installed.
3. All wiring between surge suppressors and protected equipment shall be considered protected and connected in accordance with the latest edition of the NEC.
4. A minimum of three inches of separation shall be provided between parallel runs of protected and unprotected wiring in control panels, terminal cabinets, terminal boards and other locations. In no case shall protected and unprotected wiring be bundled together or routed through the same conduit.

B. Low Voltage and Comm/Data Equipment Surge Suppressors

1. Install SPD equipment according to manufacturer's recommendations.
2. All electronic equipment/systems utilizing cord, plug or hardwired connectors shall be bonded to the building electrical system ground, building frame or driven ground rod and shall be provided with a multi-stage suppression system.
3. Contractor must properly match SPD equipment to equipment being protected, including wire sizes, operating voltages, currents and number of conductors.
4. Contractor must coordinate with providers of all equipment being protected and provide SPD equipment which meets these specifications.
5. Suppressors shall be installed in a neat manner. All hardwired low-voltage circuit lead lengths (conductor/wire distance) shall be a minimum of 3 wire feet. Make certain that the referenced ground connections are of a lesser distance (conductor/wire length) than that of the suppressor to the protected equipment.
6. Equipment shall be installed following manufacturer's recommendations and guide- lines in compliance with NEC Article 280/250 for grounding and bonding; and NEC Article 110-9 and 110-10 for over-current protection.
7. Provide required enclosures (indoor or outdoor) for protectors adjacent to each electronic system. Supplier to provide cabinet large enough to include mounting protectors within system cabinet.

C. Quality Control

1. Disconnect suppressor prior to testing of service entrance distribution equipment and panel boards.
2. Supply certified test reports for all tested parts, elements and/or systems or where required by the Owner to substantiate published ratings of claims.

END OF SECTION

SECTION 28 00 00

ELECTRONIC SECURITY

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Division 01 - General Requirements shall be considered a part of this section and shall have the same force as if printed herein full.

1.2 QUALITY ASSURANCE

A. Specifications, Standards and Codes: All work shall be in accordance with the following:

1. The 2023 edition of the National Electrical Code (NFPA 70)
2. The latest adopted edition of the Life Safety Code (NFPA 101)
3. The 2021 edition of the International Building Code
4. Building Industry Consulting Service International (BICSI)
5. Telecommunications Distribution Methods Manual (TDMM)
6. American National Standards Institute (ANSI)
7. The National Electrical Safety Code (NESC)
8. The National Electrical Safety Code (ANSI C-2)
9. National Electrical Manufacturers Association (NEMA)
10. Telecommunications Industries Association (TIA)
11. Electronic Industries Association (EIA)
12. Institute of Electrical & Electronics Engineers (IEEE)
13. Underwriters Laboratories (UL)
14. American Standards Association (ASA)
15. Federal Communications Commission (FCC)
16. Occupational Safety and Health Administration (OSHA)
17. American Society of Testing Material (ASTM)
18. Americans with Disabilities Act (ADA)
19. Local city and county ordinances governing electrical work.
20. In the event of conflicts, the more stringent provisions shall apply.

1.3 SCOPE

A. The work to be performed under this section of the Specifications shall include all labor, material, equipment, and tools required for the complete installation of the work indicated on the Drawings and as specified herein.

B. All materials, that are a part of the Electronic Security Infrastructure and necessary to its proper operation, but not specifically mentioned and shown on the Drawings, shall be furnished, and installed without additional charge.

C. The Drawings and Specifications are complementary to each other and what is called for by one shall be as binding as if called for by both. If a discrepancy exists between the Drawing and Specifications, the higher cost shall be included, and the engineer shall be notified of the discrepancy.

SECTION 28 00 00

ELECTRONIC SECURITY

1.4 WORK INCLUDED

A. The Electronic Security Infrastructure installed, and work performed under this division of the Specifications shall include but not necessarily be limited to the following:

1. IP Video Surveillance
2. Access Control
3. All other applicable Division 27 sections
4. Conduits, Raceways, Racks, Cabinets and Equipment Mounting Boards
5. Grounding and Bonding

1.5 DEFINITIONS

A. Terms: The following definitions of terms supplement those of the General Requirements and are applicable to Division 27 - Communications:

1. Provide: As used herein shall mean “furnish, install and test (if applicable) complete.”
2. Infrastructure: As used herein shall mean cable, conduit, raceway, cable tray or j-hooks with all required boxes, fittings, connectors, and accessories; completely installed.
3. Work: As used herein shall be understood to mean the materials completely installed, including the labor required.

1.6 DRAWINGS

A. Drawings are generally diagrammatic and show the arrangement and location of pathways, outlets, support structures and equipment. The Contractor shall coordinate the structural and finish conditions affecting his work and arrange his work accordingly. Should conditions on the job make it necessary to make adjustments to pathways or materials, the Contractor shall so advise the Engineer and secure approval before proceeding with such work.

B. Where exact locations are required by equipment for stubbing-up and terminating conduit concealed in floor slabs, the Contractor shall provide shop drawings, equipment location drawings, foundation drawings, and any other data required to locate the concealed conduit before the floor slab is poured.

C. Materials, equipment, or labor not indicated but which can be reasonably inferred to be necessary for a complete installation shall be provided. Drawings and Specifications do not undertake to indicate every item of material, equipment, or labor required to produce a complete and properly operating installation.

D. The right is reserved to make reasonable changes in locations of equipment indicated on Drawings prior to rough-in without increase in contract cost.

E. The Contractor shall not reduce the size or number of conduit runs indicated on the Drawings without the written approval of the Engineer.

F. Any work installed contrary to Contract Drawings shall be subject to change as directed by the Engineer, and no extra compensation will be allowed for making these changes.

G. The location of equipment, support structures, outlets, and similar devices shown on the Drawings are approximate only. While drawings will be scaled, they shall not be used to dimension device locations. Obtain layout dimensions for equipment from Architectural plans unless otherwise noted.

H. Schematic diagrams shown on the Drawings indicate the required functions only. The technology of a particular manufacturer may be used to accomplish the functions indicated without exact adherence to the schematic Drawings shown. Additional labor and materials required for such deviations shall be furnished at the Contractor's expense.

I. Verify the ceiling type, ceiling suspension systems, and clearance above hung ceilings prior to ordering cabling and associated hardware. Notify the Engineer of any discrepancies.

J. Review all architectural drawings for modular furniture.

K. Portions of these Drawings and Specifications are abbreviated and may include incomplete sentences. Omissions of words or phrases such as "the Contractor shall," "shall be," "as indicated on the Drawings," "in accordance with," "a," "the" and "all are intended" shall be supplied by inference.

1.7 SUBMITTALS

A. Provide submittals for the following systems:

1. IP Video Surveillance
2. Access Control
3. Conduits, Raceways, Racks, Cabinets and Equipment Mounting Boards
4. Grounding and Bonding

B. Submit for approval, details of all materials, equipment, and systems to be furnished. Work shall not proceed without the Owner and/or the Project Manager's approval of the submitted items.

1. Submittals for individual systems and equipment assemblies that consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered, reviewed, or stored, and such submittals will not be returned except at the request and expense of the Contractor.
2. Contractor shall generate shop drawings. Modify reviewed and accepted shop drawings to include revisions based upon completion of work. Submit shop drawings with record drawings on hard copy.
3. Shop drawings shall include equipment racks, patch panels, termination blocks, connection details, rack mounting details and any other details not included in the construction drawings.

C. Any materials and equipment listed that are not in accordance with Specification requirements may be rejected.

D. The approval of material, equipment, systems, and shop drawings is a general approval subject to the Drawings, Specifications, and verification of all measurements at the job. Approval does not relieve the Contractor from the responsibility of shop drawing errors. The Contractor shall carefully check and correct all shop drawings prior to submission for approval.

E. Materials List: Submit a complete materials list indicating all equipment to be provided as part of this section.

F. Samples: Submit selection and verification samples of finishes, colors, and textures as requested.

G. Complete details of equipment mounting configuration.

H. Manufacturing assembly and testing procedures and forms.

I. Installation testing and check out procedures and forms to be used by the Contractor and Architect and/or Consultant.

J. The conduit plans, equipment plans, riser diagrams, block diagrams and details are to be submitted in the latest version of Revit or AutoCAD and shall be submitted on a minimum of 'D' size drawings. Documents submitted in any other manner including marked up sets of the bid documents shall receive immediate rejection and will not be reviewed. A complete, electronic set of as-built documents will be issued at the completion of the project.

K. Submittals issued in a manner inconsistent with the requirements of these specifications shall receive immediate rejection and will not be reviewed. Submittals issued containing materials, products and/or equipment that is not listed or approved by addendum shall receive immediate rejection and will not be reviewed.

1.8 QUALITY ASSURANCE

A. Equipment and materials required for installation under these Specifications shall be the current model and new (less than one [1] year from the date of manufacture), unused and without blemish or defect.

B. Equipment shall bear labels attesting to Underwriters Laboratories, where subject to label service. Manufacturers of equipment and materials pertinent to these items shall have been engaged in the manufacture of said equipment a minimum of three (3) years and, if so directed by the Owner, be able to furnish proof of their ability by submitting affidavits and descriptive data about their product including size and magnitude comparable to requirements specified herein.

1.9 CONTRACTOR QUALIFICATIONS

A. The Contractor shall have total responsibility for the coordination and installation of the work shown and described in the Drawings and Specifications. The Contractor shall be a company specializing in the design, fabrication and installation of integrated communications systems.

B. Electronic Security Systems specified shall be installed under the direction of a qualified Contractor. Qualification requirements shall include submittal by the Contractor to the Architect of the following:

1. List of previous projects of this scope, size, and nature; including names and sizes of projects, description of work, time of completion and names of contact persons for reference.
2. Shall certify that they are manufacturer-authorized for work to be performed.

C. Contractor must employ at least one (1) full-time Registered Communications Distribution Designer (RCDD).

1.10 COORDINATION WITH OTHER TRADES

A. The Contractor shall coordinate Electronic Security work with that of other sections as required ensuring that the entire communications work will be carried out in an orderly, complete, and coordinated fashion.

1.11 SITE INVESTIGATION

A. Prior to submitting bids of the project, visit the site of the work to become aware of existing conditions that may affect the cost of the project. Where work under this project requires extension, relocation, reconnections or modifications to existing equipment or systems, the existing equipment or systems shall be restored to their original condition before the completion of this project.

1.12 PERMITS

A. Obtain all permits and inspections for the installation of this work and pay all charges incident thereto. Deliver to the Owner all certificates of said inspection issued by authorities having jurisdiction.

1.13 RENOVATIONS AND ADDITIONS

A. All work that would adversely affect the normal operation of the other portions of the Owner's property shall be done at a time other than normal working hours.

B. Prior to submitting bids on the project, visit the site of the work to become aware of existing conditions that may affect the cost of the project.

C. Where work under this project requires extension, relocation, reconnections or modifications to existing equipment or systems, the existing equipment or systems shall be restored to their original and operating condition. Remove all equipment indicated to be demolished, including outlets, devices, raceways, and support structures.

D. Care shall be exercised in the removal and storage of equipment indicated to be relocated or removed and reused. Prior to placing back into service, equipment shall be cleaned and marred or chipped paint surfaces touched-up.

E. Provide all coring, cutting, and patching to existing walls, floors, etc., required for the removal of existing work or the installation of new work.

1.14 OPERATION & MAINTENANCE MANUALS

A. The Contractor shall furnish two (2) hard copies and one electronic copy of operational and maintenance manuals for all systems furnished. The manuals shall include component lists, instructions for care, operation instructions, instructions for ordering replacement equipment and personnel to contact for warranty work.

1.15 APPROVALS

A. Deviations from this specification must be documented in writing to the Architect and Engineer at least twenty-one (21) business days prior to the bid date.

B. Complete catalogue data, product specifications and technical information on alternative equipment must be provided including all associated cost savings or additions, including but not limited to equipment, equipment installation, power wiring and materials, programming, documentation, and project management.

1.16 DELIVERY & HANDLING

A. General: Comply with Division 1 Product Requirements Section.

B. Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

C. Storage and Protection: Store materials and equipment in an area protected from harmful weather conditions and at temperature conditions recommended by manufacturer. After initial installation, protect equipment from exposure to dust, dirt, paint, and other contaminants.

1.17 PROJECT CONDITIONS

A. Field Measurements: Verify actual measurements/openings by field measurements before fabrication; show recorded measurements on shop drawings.

B. Scheduling: Coordinate taking field measurements, fabrication schedule and deliveries with construction progress schedule to avoid construction delays.

1.18 WARRANTY

A. Warranty: All equipment and labor provided under this section is warranted for two (2) years from Substantial Completion or System Commissioning, whichever occurs first.

B. During the warranty period, the Contractor shall perform quarterly preventative maintenance inspections on all installed equipment.

C. Nothing in the above warranty shall apply to material which has been misused or abused as follows: neglect by the owner, defects or damage caused by work or failure of work by others, ordinary wear or normal equipment adjustment.

D. Additionally, any unauthorized modifications, repairs or tampering shall constitute termination of the warranty.

1.19 TRAINING

A. The Contractor shall provide four (4) hours of on-site training for operational purposes and forty (40) hours of training for maintenance purposes at the turnover of the project.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

A. Where equipment is identified by manufacturer and catalog number, it shall be as the base of requirements for quality and performance. Where manufacturers for equipment are identified by name, the Contractor may submit for approval, similar equipment of other manufacturers as substitution. The Engineer's decision as to whether the submitted equipment is acceptable shall be final and binding.

B. All changes necessary to accommodate the substituted equipment shall be made at the Contractor's expense and shall be as approved by the Engineer. Detailed drawings indicating the required changes shall be submitted for approval at the time the substitution is requested.

C. If substitutions are made in lieu of device specified; form, dimension, design, and profile shall be submitted to the Engineer for approval.

D. Submit request for approval of substitute materials in writing to the Architect at least ten (10) days prior to bid opening.

2.2 MATERIALS

A. All materials used in this work shall be new and shall bear the inspection label of Underwriters' Laboratories Inc. or certification by other recognized laboratory.

B. The published standards and requirements of the Telecommunications Industries Association (TIA), National Electrical Manufacturers Association (NEMA), the American National Standard Institute (ANSI), the Institute of Electrical and Electronic Engineers (IEEE), and the American Society of Testing Materials (ASTM), are made a part of these Specifications and shall apply wherever applicable.

C. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts are available.

D. When more than one unit of the same class of equipment or material is required, such units shall be the products of a single manufacturer or partner manufacturers that offer a certified solution.

E. Components of an assembled unit need not be products of the same manufacturer but must offer a certified end-to-end solution.

F. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.

G. Components shall be compatible with each other and with the total assembly for the intended service.

PART 3 - EXECUTION

3.1 EXAMINATION OF CONDITIONS

A. Prior to the start of work, the Contractor shall carefully inspect the installed work of other trades and verify that such work is complete to the point where installation may properly commence. Start of work indicates acceptance of conditions.

B. Install equipment in accordance with applicable codes and regulations, and the referenced standards.

C. In the event of a discrepancy, immediately notify the Project Manager.

D. Do not proceed with installation until unsatisfactory conditions and discrepancies have been fully resolved.

3.2 PROTECTION OF SYSTEMS AND EQUIPMENT

A. Protect materials and equipment from damage during storage at the site and throughout the construction period. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, theft, moisture, extreme temperature, and rain.

B. Damage from rain, dirt, sun, and ground water shall be prevented by storing the equipment on elevated supports and covering the sides with securely fastened protective rigid or flexible waterproof coverings.

C. During installation, equipment shall be protected against entry of foreign matter on the inside and be vacuum cleaned both inside and outside before testing, operating, or painting.

D. As determined by the Project Manager, damaged equipment shall be fully repaired or shall be removed and replaced with new equipment to fully comply with requirements of the Contract Documents.

E. Damaged paint on equipment and materials shall be repainted with painting equipment and finished with the same quality of paint and workmanship as used by the manufacturer.

3.3 ACCESS TO EQUIPMENT

A. Equipment shall be installed in location and manner that will allow access for maintenance and inspection.

B. Working spaces shall be not less than specified in the National Electrical Code (NEC/NFPA 70) for voltages specified.

C. Where the Project Manager determines that the Contractor has installed equipment not accessible for operation and maintenance, equipment shall be removed and reinstalled as directed by the Project Manager, at no additional cost to the Owner. “Accessible” is defined as being capable of being reached without the use of ladders or without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping, and duct work.

3.4 CLEANING

A. During construction, and prior to Owner acceptance of the building, remove from the premises and dispose of packing material and debris caused by communications work.

B. Remove dust and debris from interiors and exteriors of components. Clean accessible current carrying elements prior to being energized.

C. General: Upon completion of the work, remove excess dust & debris, materials, equipment, apparatus, tools and similar items. Leave the premises clean, neat and orderly.

3.5 COMPLETION

A. Results Expected: Systems shall be complete and operational, and controls shall be set and calibrated. Testing, start-up, and cleaning work shall be complete.

B. Maintenance Materials: Special tools for proper operation and maintenance of the equipment provided under this Specification shall be delivered to the Owner.

3.6 TESTING AND VERIFICATION

A. See specific Division 28 sections for testing parameters of sub-systems.

B. The Contractor shall verify that requirements of this Specification are met. Verification shall be through a combination of analyses, inspections, demonstrations, and tests, as described below.

C. Verification by inspection includes examination of items and comparison of pertinent characteristics against the qualitative or quantitative standard set forth in the Specifications. Inspection may require moving or partially disassembling the item to accomplish the verification, included as part of the work at no additional cost to the Owner.

D. The Contractor shall verify by demonstrations and/or tests that the requirements of this Specification have been met. The Contractor shall demonstrate that the communications systems, components, and subsystems meet Specification requirements in the "as-installed" operating environment during the "System Operation Test." The Contractor shall measure and record temperature, humidity, and other environmental parameters.

E. The Contractor shall schedule and coordinate the final acceptance tests. The Contractor shall provide necessary instruments, labor and materials required for tests. Provide equipment manufacturer's technical representative and qualified technicians.

F. The Contractor shall satisfy all items detailed in the final acceptance check-off list (punch list). The list shall be a complete representation of specified installation requirements. At the time of final acceptance punch list items shall be corrected until the system is found to be acceptable to the Owner and the Project Manager.

END OF SECTION

SECTION 28 07 00

IP VIDEO SURVEILLANCE SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Provide IP Video Surveillance System (IPVSS) equipment-based analytics as specified herein and as shown on the schedules and drawings. The Systems Integrator shall receive, place, connect, and mount all equipment specified in this Section per the manufacturer's instructions. The Systems Integrator shall furnish all hardware, wire, connectors, and other necessary items as required for a complete and functional IPVSS system.

B. The IPVSS shall be capable of integrating an access control system by the same manufacturer as IPVSS.

C. Related Sections

1. Electrical
2. Electronic Security
3. Access Control Systems

1.2 REFERENCES

A. The General Conditions, Supplementary Conditions, and Division 1 Specifications shall apply to all work of this section.

B. Standards listed by reference, including revisions by issuing authority, form a part of this specification section to extent indicated. Standards listed are identified by issuing authority, authority abbreviation, designation number, title, or other designation established by issuing authority. Standards subsequently referenced herein are referred to by issuing authority abbreviation and standard designation.

C. Underwriter's Laboratories (UL)

1. UL 508 Industrial Control Equipment
2. NEC National Electrical Code (latest edition)

1.3 WORK INCLUDED

A. Included under this Section of the work shall be the furnishing, installation, connection, aiming and testing of the complete IPVSS system including, but not limited to, cameras, housings, mounts, cables, monitors, network switches, network video recorders and storage equipment, and fiber optic systems.

B. Major Sub-systems include:

1. Access Control System
2. Intercom System

C. The finalized field of view must be approved by the owner prior to sign off.

D. Provide 1 spare interior IP fixed camera.

E. Provide 1 spare exterior IP fixed camera.

F. All cameras shall provide at minimum 3 mega pixel resolution Refer to camera schedule for exact models and accessories.

1. All exterior fixed dome or bullet cameras are for monitoring outdoor areas and shall be 6 mega pixels minimum.
2. All exterior pan tilt zoom cameras shall be 4 mega pixels minimum
3. All exterior multi-sensor cameras shall be 5 mega pixels per sensor minimum.
4. All License Plate Recognition cameras shall be 2 mega pixels minimum with a 4.7-84.6 mm lens minimum.
5. Interior fixed cameras shall be 3 mega pixels minimum
6. Interior multi-sensor shall be 3 mega pixels per sensor minimum.
7. Interior fisheye cameras shall be 8 mega pixels minimum.

1.4 APPROVALS

A. General

1. Submittals shall be made in accordance with the General Provisions of these specifications.

B. Specific Requirements

1. Submit catalog cuts for all equipment and devices being furnished under this Section.
2. Submit a complete IPVSS System riser diagram. Diagram shall include labeling of each camera and its corresponding head end equipment input, interconnecting wiring of all components including, but not limited to, digital controllers, network video recorders, camera power supplies, monitors, control keyboards, and interface connections.
3. Submit plan drawings showing location, mounting and viewing angle of each camera.

1.5 DESCRIPTION

A. The IPVSS shall monitor spaces as shown on the drawings and function as shown on the IPVSS functional schematic.

B. A Virtual Matrix Controller shall be furnished and installed to provide auto select and manual selection of video cameras.

C. All IPVSS cameras shall be equipped with auto-iris lens.

D. Video Switching/Control

1. Some consoles are equipped with two intercom call-up monitors for movement control. These are designated as shown on the drawings. The first monitor (ex. M1) shall view the side of the door from which the intercom call was initiated. The second monitor (ex. M2) shall view the opposite side of the door. Cameras on both sides of a door will be called up and display simultaneously upon acknowledging an intercom call. If a door has only one IPVSS camera viewing it, the monitor displaying the side without a camera shall be blank. Activating an intercom by touching the intercom icon on the touch screen shall switch the associated cameras to these intercom call-up monitors. For conditions such as elevator lobbies, monitors shall display lobby video and cab video.

E. The IPVSS system shall be 100% IP based.

F. All interior camera wiring shall be Category 6. Category 5e is not acceptable for video.

G. All exterior cameras located more than 300'-0" away from the nearest Telecom Room shall be fiber optic video transmission.

H. All the pan tilt zoom cameras shall have programmable pre-set positions.

I. All cameras shall have digital motion detection built in the software. System recording shall be dormant for areas that have no activity. Real time recording shall occur upon motion.

J. System shall include cloud management (remote monitoring/management) from remote computers, phones, tablets, etc.

1. Cloud management shall be included with the system, free-of-charge with no additional monthly or licensing fees.

K. System storage shall be via local server/Network Video Recorder (NVR).

PART 2 - PRODUCTS

2.1 MATERIALS

A. Except as otherwise specified herein or in the General Conditions, the equipment and materials of this Section shall be products of the following listed manufacturers, subject to compliance with the specification requirements and provided each manufacturer meets all requirements of the Quality Assurance Section of this specification.

B. Cameras

1. IPVSS cameras shall be U.L. listed, NDAA Compliant and shall be the standard product of one manufacturer complying with not less than the specifications contained herein. Installation of each camera shall include mounting brackets and/or camera housings fully compatible with the camera provided. Please refer to the camera schedule for details on basis of design models and required mounting hardware.
    a. Outdoor Dome-Type Camera with Infrared.
        1) Basis of Design Product: 6.0C-H5A-DO1-IR, by Avigilon.
        2) Performance:
            a) Image Sensor: 1/1.8 inch progressive scan CMOS.
            b) Maximum Resolution:
                (1) Aspect Ratio: 16:9: 3200 x 1800.
                (2) Aspect Ratio: 3:2: 3072 x 2048.
            c) Imaging Rate: (50 Hz/60 Hz): 25 fps/30 fps.
            d) Dynamic Range:
                (1) WDR Off: 85 dB.
                (2) WDR On: 120 dB.
            e) Minimum Illumination:
                (1) Color: 0.055 lux.
                (2) Monochrome: 0.028 lux.
                (3) With IR: 0 lux.

f) Field of View:
(1) Horizontal angle: 16:9: 52 degrees to 92 degrees.
(2) Horizontal angle: 4:3: 41 degrees to 73 degrees.
(3) Vertical angle: 16:9: 29 degrees to 51 degrees.
(4) Vertical angle: 4:3: 27 degrees to 48 degrees.

b. Outdoor Bullet-Type Camera with Infrared.
1) Basis of Design Product: 6.0C-H5A-BO1-IR, by Avigilon.
2) Performance:
a) Image Sensor: 1/1.8 inch progressive scan CMOS.
b) Maximum Resolution:
(1) Aspect Ratio: 16:9: 3200 x 1800.
(2) Aspect Ratio: 3:2: 3072 x 2048.
c) Imaging Rate: (50 Hz/60 Hz): 25 fps/30 fps.
d) Dynamic Range:
(1) WDR Off: 85 dB.
(2) WDR On: 120 dB.
e) Minimum Illumination:
f) Color: 0.055 lux.
(1) Monochrome: 0.028 lux.
(2) With IR: 0 lux.
g) Field of View:
(1) Horizontal angle: 16:9: 52 degrees to 92 degrees.
(2) Horizontal angle: 4:3: 41 degrees to 73 degrees.
(3) Vertical angle: 16:9: 29 degrees to 51 degrees.
(4) Vertical angle: 4:3: 27 degrees to 48 degrees.

c. Pan-Tilt-Zoom Camera.
1) Basis of Design Product: 4.0C-H5A-PTZ-DP36, by Avigilon.
2) Performance:
a) Image Sensor: 1/2.5 inch progressive scan CMOS.
b) Zoom:
(1) Image Stabilization On: 30x maximum.
(2) Image Stabilization Off: 36x maximum.
c) Maximum Resolution: 16:9: 2688 x 1512.
d) Imaging Rate: 30 fps maximum.
e) Minimum Illumination:
(1) Color: 0.3 lux.
(2) Monochrome: 0.09 lux.
f) Field of View:
(1) Horizontal angle: 69.7 degrees to 2.2 degrees.
(2) Vertical angle: 42.8 degrees to 1.3 degrees.
(3) Zoom:
(4) 36x with image stabilization off
(5) 30x with image stabilization on
(6) Mounting hardware and accessories reflected on camera schedule

d. Outdoor 270 Degree multi-sensor Camera
1) Basis of Design Product: 15C-H4A-3MH-270 – H4 multi-sensor, by Avigilon.
2) Performance:
a) Image Sensors: 1/2.8 inch progressive scan CMOS.
b) Aspect Ratio: 4:3.
c) Active Pixels (H x V): 2592 x 1944 per sensor.
d) Imaging Area (H x V): 5.18 mm x 3.89mm (0.204 inches x 0.153 inches).
e) Imaging Rate: 15 fps at 60 Hz and 17 fps at 50Hz.
f) IR Illumination:
(1) Color Mode: 0.025 lux (F1.2).

(2) Mono Mode 0.005 lux (F1.2).
(3) With IR Illuminator Active: 0 lux.
g) Dynamic Range: 100 dB with WDR active.
h) Resolution Scaling: Down to 640 x 480.
i) Angle of View: 103 degrees.
j) Mounting hardware and accessories reflected on camera schedule

e. Outdoor 180 Degree multi-sensor Camera
1) Basis of Design Product: 15C-H4A-3MH-180 – H4 multi-sensor, by Avigilon.
2) Performance:
a) Image Sensors: 1/2.8 inch progressive scan CMOS.
b) Aspect Ratio: 4:3.
c) Active Pixels (H x V): 2592 x 1944 per sensor.
d) Imaging Area (H x V): 5.18 mm x 3.89mm (0.204 inches x 0.153 inches).
e) Imaging Rate: 15 fps at 60 Hz and 17 fps at 50Hz.
f) IR Illumination:
(1) Color Mode: 0.05 lux (F1.6).
(2) Mono Mode 0.01 lux (F1.6).
(3) With IR Illuminator Active: 0 lux.
g) Dynamic Range: 100 dB with WDR active.
h) Resolution Scaling: Down to 640 x 480.
i) Angle of View: 72 degrees.
3) Mounting hardware and accessories reflected on camera schedule

f. Outdoor 360 Degree multi-sensor Camera
1) Basis of Design Product: 20C-H4A-4MH-360 – H4 multi-sensor, by Avigilon.
2) Performance:
a) Image Sensors: 1/2.8 inch progressive scan CMOS.
b) Aspect Ratio: 4:3.
c) Active Pixels (H x V): 2592 x 1944 per sensor.
d) Imaging Area (H x V): 5.18 mm x 3.89mm (0.204 inches x 0.153 inches).
e) Imaging Rate: 13 fps at 60 Hz and 13 fps at 50Hz.
f) IR Illumination:
(1) Color Mode: 0.025 lux (F1.2).
(2) Mono Mode 0.005 lux (F1.2).
(3) With IR illuminator Active: 0 lux.
g) Dynamic Range: 100 dB with WDR active.
h) Resolution Scaling: Down to 640 x 480.
i) Angle of View: 103 degrees.
3) Mounting hardware and accessories reflected on camera schedule

g. LPR Camera with 4.7 - 84.6 mm lens.
1) Basis of Design Product: 2.0C-H5A-B1, by Avigilon.
2) Performance:
a) Image Sensor: 1/2.8 inch progressive scan CMOS.
b) Maximum Resolution:
c) Aspect Ratio: 16:9: 1920 x 1080.
d) Imaging Rate: (50 Hz/60 Hz): 25 fps/30 fps.
e) Dynamic Range:
(1) WDR Off: 83 dB.
(2) WDR On: 126 dB., dual exposure (30 fps).
(3) WDR On: 132 dB., triple exposure (20 fps or less).
f) Minimum Illumination:
(1) Color: 0.039 lux.
(2) Monochrome: 0.020 lux.
g) Field of View:
(1) Horizontal angle: 16:9: 4.1 degrees to 60 degrees.

(2) Vertical angle: 16:9: 2.3 degrees to 34 degrees.

h) Required Accessories:

(1) Standard format enclosure with heater, sunshield and PoE passthrough for camera.

(2) External IR Illuminator, POE+.

(3) Enclosure Mounting Hardware reflected on camera schedule

h. Indoor Dome Type Camera with 3.3-9 mm lens

1) Basis of Design Product: 4.0C-H5A-D1, by Avigilon.

2) Performance:

a) Image Sensor: 1/2.8 inch progressive scan CMOS.

b) Maximum Resolution:

(1) Aspect Ratio: 16:9: 2560 x 1440.

(2) Aspect Ratio: 4:3: 2304 x 1728.

c) Imaging Rate:

(1) WDR Off: (50 Hz/60 Hz): 25 fps/30 fps.

(2) WDR On: (50 Hz/60 Hz): 20 fps/20 fps.

d) Dynamic Range:

(1) WDR Off: 83 dB.

(2) WDR On: 126 dB.

e) Minimum Illumination:

(1) Color: 0.030 lux.

(2) Monochrome: 0.015 lux.

f) Field of View:

(1) Horizontal angle: 16:9: 34 degrees to 92 degrees.

(2) Horizontal angle: 4:3: 34 degrees to 92 degrees.

(3) Vertical angle: 16:9: 18 degrees to 50 degrees

(4) Vertical angle: 4:3: 25 degrees to 68 degrees

i. Indoor 270 Degree multi-sensor Camera:

1) Basis of Design Product: 9C-H4A-3MH-270 – H4 multi-sensor, by Avigilon.

2) Performance:

a) Image Sensors: 1/2.8 inch progressive scan CMOS.

b) Aspect Ratio: 4:3.

c) Active Pixels (H x V): 2048 x 1536 per sensor.

d) Imaging Area (H x V): 5.18 mm x 3.89mm (0.204 inches x 0.153 inches).

e) Imaging Rate: 24 fps at 60Hz and 25 fps at 50Hz.

f) IR Illumination:

(1) Color Mode: 0.025 lux (F1.2).

(2) Mono Mode 0.005 lux (F1.2).

(3) With IR Illuminator Active: 0 lux.

g) Dynamic Range: 100 dB with WDR active.

h) Resolution Scaling: Down to 640 x 480.

i) Angle of View: 103 degrees.

3) Mounting hardware and accessories reflected on camera schedule.

j. Indoor 180 Degree multi-sensor Camera:

1) Basis of Design Product: 9C-H4A-3MH-180 – H4 multi-sensor, by Avigilon.

2) Performance:

a) Image Sensors: 1/2.8 inch progressive scan CMOS.

b) Aspect Ratio: 4:3.

c) Active Pixels (H x V): 2048 x 1536 per sensor.

d) Imaging Area (H x V): 5.18 mm x 3.89mm (0.204 inches x 0.153 inches).

e) Imaging Rate: 24 fps at 60 Hz and 25 fps at 50Hz.

f) IR Illumination:

(1) Color Mode: 0.05 lux (F1.6).

(2) Mono Mode 0.01 lux (F1.6).

(3) With IR Illuminator Active: 0 lux.
g) Dynamic Range: 100 dB with WDR active.
h) Resolution Scaling: Down to 640 x 480.
i) Angle of View: 72 degrees.
3) Mounting hardware reflected on camera schedule.
k. Indoor 360 Degree multi-sensor Camera:
1) Basis of Design Product: 12C-H4A-4MH-360 – H4 multi-sensor, by Avigilon.
2) Performance:
a) Image Sensors: 1/2.8 inch progressive scan CMOS.
b) Aspect Ratio: 4:3.
c) Active Pixels (H x V): 2048 x 1536 per sensor.
d) Imaging Area (H x V): 5.18 mm x 3.89mm (0.204 inches x 0.153 inches).
e) Imaging Rate: 20 fps at 60 Hz and 20 fps at 50Hz.
f) IR Illumination:
(1) Color Mode: 0.025 lux (F1.2).
(2) Mono Mode 0.005 lux (F1.2).
(3) With IR Illuminator Active: 0 lux.
g) Dynamic Range: 100 dB with WDR active.
h) Resolution Scaling: Down to 640 x 480.
i) Angle of View: 103 degrees.
3) Mounting hardware and accessories reflected on camera schedule.
l. 8.0 MP Fisheye Camera with 1.4 mm lens.
1) Basis of Design Product: 8.0C-H5A-FE-DO1, by Avigilon.
2) Performance:
a) Image Sensor: 1/1.8 inch progressive scan CMOS.
b) Imaging:
(1) Warped 360-degree streams with full analytics features:
(a) Primary Stream Maximum Resolution: 2048 x 2048.
(b) Secondary Stream Maximum Resolution: 515 x 512
(c) Tertiary Stream Maximum Resolution: 320 x 320.
(2) DE warped video streams with analytics disabled:
(a) Primary Stream:
i. 180 Degrees by 2: 2304 x 928.
ii. 120 Degrees by 3: 1536 x 928.
iii. 90 Degrees by 4: 1152 x 928.
(b) Secondary Stream:
i. 180 Degrees by 2: 576 x 232.
ii. 120 Degrees by 3: 384 x 232.
iii. 90 Degrees by 4: 288 x 232.
c) Imaging Rate; (50 Hz/60 Hz): 25 fps/30 fps.
d) Dynamic Range:
(1) WDR Off: Up to 83 dB.
(2) WDR On: Up to 120 dB.
e) Minimum Illumination:
(1) Color: 0.20 lux.
(2) Monochrome: 0.10 lux.
f) Operational Range:
(1) Temperature: -40 degrees C to 60 degrees C (-40 F to 140 F).
(2) Relative Humidity: 0–95 percent (non-condensing).

C. Remote Monitoring Workstations

1. IPVSS Workstations shall be the standard products of one manufacturer and compatible with the total system specified herein and complying with these specifications. Workstations and cameras shall be provided by the same manufacturer.
   a. Form Factor: Small Form Factor.
      1) 11-1/2 by 3-5/8 by 11-7/16 inches (292.0 by 92.6 by 290.0 mm).
      2) Monitor Interfaces: Support no less than four (4) monitors.
      3) mini-DisplayPort (mDP).
      4) High-Definition Multimedia Interface (HDMI) with supplied adapter.
      5) DisplayPort (DP) with supplied adapter.
   b. Resolution: Up to 3840 x 2160 (4K).
   c. Refresh Rate: Up to 60Hz.
   d. Electrical Power
      1) Input: 100 to 240 V AC, 50/60 Hz, auto-switching.
      2) Supply: Single, non-redundant.
      3) Maximum Power Consumption: No greater than 290W.
   e. Operational Range
      1) Temperature: 10 degrees C to 35 degrees C [50F to 95F].
      2) Relative Humidity: 20–80 percent (non-condensing).
      3) Vibration: Between 5 Hz and 350 Hz at 0.0002 G^2/HzS.
      4) Shock: 40 G +/- 5 percent with pulse duration of 2 msec +/- 10 percent.
      5) Altitude: -15.2 m to 3048 m (-50 ft to 10,000 ft).
   f. Performance
      1) IPVSS Workstation shall be capable or using a minimum of four (4) 1080p displays connected to any combination of mDP, DP, and HDMI monitor interfaces.
      2) Performance at high quality in the Client software at 200 percent DPI scaling using four (4) 4K displays:
         a) Thirty-five (35) 2MP video streams at 15 fps.
         b) Twenty-five (25) 4MP video streams at 15 fps.
         c) Fourteen (14) 8MP video streams at 15 fps.
         d) Fourteen (14) 2MP video streams at 30 fps.
         e) Fourteen (14) 4MP video streams at 30 fps.
         f) Five (5) 8MP video streams at 30 fps.
      3) Performance at high quality in the Client software using four (4) 1080p displays:
         a) Thirty-five (35) 2MP video streams at 15 fps.
         b) Twenty-five (25) 4MP video streams at 15 fps.
         c) Fourteen (14) 8MP video streams at 15 fps.
         d) Twenty (20) 2MP video streams at 30 fps.
         e) Sixteen (16) 4MP video streams at 30 fps.
         f) Five (5) 8MP video streams at 30 fps.
   g. Operating System: Microsoft Windows 10 IoT Enterprise LTSB.
      1) Processor: Intel® Core™ i5.
      2) Memory: 16 GB DDR4 RAM.
      3) Storage: 256 GB Solid State Drive (SSD) system drive.
      4) Network Interface: 2 Gigabit Ethernet RJ-45 ports (1000Base-T).
      5) Video Outputs: 4 active (4 × mDP).
      6) Optical Drive: DVD-RW.

D. Monitors

1. IPVSS monitors shall be the standard products of one manufacturer and compatible with the total system specified herein and complying with these specifications. Monitors and cameras shall be provided by the same manufacturer.

2. IPVSS monitors shall be color solid state TFT LCD flat panel type as indicated on the drawings and as specified herein. Monitor controls shall be on-off, brightness, contrast, vertical hold, and horizontal hold. All monitors shall be U.L. listed.
3. 32" monitors shall be mounted as shown on the drawings. Monitors shall comply with not less than the following specifications:
   a. LCD Panel Pixel Array 1280 x 1024, 75 Hz
   b. Panel Aspect Ratio 4:3 composite, 5:4 VGA
   c. Pixel Pitch 0.294 x 0.294mm
   d. Contrast Ratio500:1
   e. Viewing Angle (H/V) 150°/130°
   f. Response Time 8 ms

4. Thirty-Two (32) inch monitors shall be mounted as shown on the drawings. Monitors shall comply with not less than the following specifications:
   a. Native Resolution 1366 x 768 WXGA
   b. Pixel Pitch 0.681 x 0.681 mm
   c. Contrast Ratio 10,000:1
   d. Viewing Angle 178°/178°
   e. Response Time 5 ms
   f. Power Consumption 375 W

E. IPVSS Management Software

1. IPVSS Management Software shall be able to display any camera on any monitor over the network.
2. IPVSS Management Software shall include unlimited viewing clients, a free Mobile App, High Definition Stream Management and Appearance Search technology.
3. IPVSS Management Software must be ONVIF Profile S and T compliant and an open platform to accept multiple camera manufacturers.
4. IPVSS Management Software shall not require recurring annual support fees and must provide free updates within the version software.
5. The IPVSS Management Software shall include Managed Cloud Services (ACS) at no additional cost for centralized access, mobile access, and system health monitoring.
6. The IPVSS Management Software shall be capable of hosting up to Video Management Servers per site, a minimum of 300 cameras per server, and a minimum of 10,000 cameras per site.
7. IPVSS Management Software must include graphic map features to depict camera locations.
8. IPVSS Management Software must support video analytics and artificial intelligence (AI) capabilities, including appearance search, analytic event rule triggers, and unusual motion detection technology.
9. IPVSS Management Software shall include forensic search capabilities with bookmark, event, alarm, and thumbnail search options.
10. IPVSS Management Software must provide functionality that automatically detects and flags events within software to focus the operator's attention. Functionality shall be capable of event handling and filtering events that allows inclusion or exclusion of unnecessary event types.
11. IPVSS Management Software must provide the ability to configure and manage alarms and events with the following capabilities:
    a. Define event triggers that are configured to result in an alarm
    b. Generates alarms based off the following event types:
       1) Detect events that occur within a camera's field of view
       2) Detect presence of persons within a sensor's range
       3) Detect if video or audio signal is lost and alert system administrator.
       4) Door activity detected by an access control application.
       5) Notify users of system errors.
       6) Receive alarms from third party systems and configured to be monitored.
       7) Support receiving digital input triggers and triggering digital outputs from:

a) An Input/Output board.
b) Supported IP camera, encoder, or sensor.
c) Integrated systems, including POS.

c. Receives events from devices through ONVIF driver.
d. Configure rules to trigger specific video operations
e. Supports receiving Simple Network Management Protocol (SNMP) messages from servers and alert users.
f. Customizes and forwards alarm and event notifications to the following:
   1) Users logged into client application
   2) Users logged into mobile application
   3) Configured email addresses
   4) External entities and third-party software, such as central monitoring stations and call centers.
g. Escalates alarms from one user or group to another if alarm is unacknowledged for a preset duration.

12. IPVSS management software must support objects in area, object Loitering, objects crossing a defined line, object appears or enters area, object does not present in area, objects leave area, object stops in area, anticipated direction of travel violated, and tampering & scene change analytic event types when captured by supported cameras.
13. The software shall include information overlays based on camera name, camera location, playback timestamp with option of displaying device time or local time, recording indicator, motion activity, video analytics object activity with colored bounding boxes, and video analytics unusual motion anomaly detection with colored bounding boxes indicating areas of motion.
14. The software shall support alarm management operations through video monitoring interface.
    a. Including but not limited to:
       1) Designated tab for reviewing alarms
       2) Interface supports for sequential viewing of alarms
       3) Interface supports sorting of alarms by:
          a) Priority
          b) Activation time.
          c) Status
       4) Interface supports filtering alarms by status in the following priority:
          a) Assigned to me.
          b) Active alarms (unassigned).
          c) Alarms assigned to others.
          d) Acknowledged alarms.
       5) Supports ability to assign alarms to user.
       6) Supports ability to acknowledge alarms
       7) Supports ability to bookmark alarms.
       8) Designate one or more regions in video display area for displaying video directly linked to triggered alarms or rules.
          a) Supports ability to acknowledge alarms from designated video display area.

15. The software shall support modifications to the following image quality and image rate parameters for each individual video source:
    a. Video streaming format.
    b. System optimized recording profile or manual configuration.
    c. Keyframe interval.
    d. Secondary stream for live viewing.
    e. Configure video streaming at a lower image rate when scene is idle.
    f. Customize primary and secondary stream on supported cameras.

16. The software shall provide support for an unlimited number of monitors used for monitoring video and audio streams connected to a single workstation.
    a. Displays all video sources connected to system.
    b. Support ability to drag and drop items from system tree into video monitoring area.
    c. Support monitoring live and recorded video and audio streams simultaneously on same monitor.
    d. Support viewing same live or recorded video stream at different zoom levels and areas of interest.
    e. Support ability to switch from live to recorded video on demand for an instant replay of recently recorded video.
    f. Support creation of unlimited views with unique layouts of video streams.
    g. Support ability to toggle between tiled and full-screen view.
    h. Support ability to save configured display setting.
    i. Support ability to cycle through views (guard tour) based on a specified interval.
    j. Supports live or recorded video monitoring of 1 to 64 video streams simultaneously on a single monitor.
    k. Supports displaying videos streams in the following standard layouts:
        1) Full Screen.
        2) 2 x 2.
        3) 3 x 3.
        4) 4 x 4.
        5) 5 x 5.
        6) 6 x 6.
        7) 8 x 8.
        8) 1 + 5.
        9) 1 + 7.
        10) 1 + 12.
        11) 2 + 8.
    l. Provides tools to build custom video monitoring layouts.

F. Network Video Recording System (Long Term Recording and Playback)

1. NVR (Network Video Recorder) system must be capable of managing a combined 2100 Mbps of total throughput with handling for simultaneous recording, playback and live streaming.
    a. Recording: 1500 Mbps.
    b. Playback: 600 Mbps.

2. The NVR shall provide products capable of supporting the following:
    a. Events search such as motion, digital input, classified object, arbitrary events and tampering across all features enabled cameras connected to the system.
    b. Object similarity search up to 200 cameras simultaneously. When combined with facial recognition the system must be capable of supporting up to 100 cameras using object similarity and up to 50 cameras using facial recognition features.

3. System Certifications:
    a. UL and cUL certification marks for Canada/USA.
    b. NRCS certification mark for USA.

4. Electromagnetic Emissions Certifications:
    a. CFR Title 47, FCC Part 2, 15 Class A.
    b. ICES-003 Class A.
    c. EN 55032 Class A.
    d. EN 61000-3-2.
    e. EN 61000-3-3.

5. Electromagnetic Immunity Standards:
   a. EN 55024.

6. Safety Standards:
   a. UL/CSA/IEC/EN 60950-1.

7. System Design:
   a. Operating System: Microsoft Windows Server 2016.
   b. Processor: Intel Xeon.
   c. RAM: 32GB DDR4.
   d. Video Output: VGA.

8. Operating System Storage: Two (2) M.2 SSD drives configured with subsequent write capability, data mirroring, and redundancy, such that one (1) drive may be removed, replaced, or fail without system compromise (RAID 1).
9. Mounting: Standard server enclosure (rack) mounting, requiring no greater than a 2U configuration.
10. Electrical Power:
    a. Input: 100 to 240 V AC, 50/60 Hz, auto-switching.
    b. Appliance must be configurable for dual power supplies that may be replaced without the need to power down (hot-swappable).

G. Digital Video Network Equipment (core switch typically needs more ports and SFP's. consult with data supplier to update specs if needed)

1. The digital IPVSS network shall be a stand-alone 1000 MB network furnished and installed by the ESC contractor. The owner's network may be, at the option of the owner, linked to the digital video network for accommodation of remote viewing PCs, but shall not be used as the primary means of transporting digital video.
2. Switches shall be 12, 24 or 48 port as applicable and defined below.
3. Protocol Independent Multicast (PIM) for IP multicast routing is supported, including PIM sparse mode (PIM-SM), PIM dense mode (PIM-DM), and PIM sparse-dense mode. The IP Services image is required.
4. Inter-VLAN IP routing for full Layer 3 routing between 2 or more VLANs.
5. Distance Vector Multicast Routing Protocol (DVMRP) tunneling interconnects 2 multicast-enabled networks across non-multicast networks.
6. IEEE 802.1x allows dynamic, port-based security, providing user authentication.
7. IEEE 802.1x with VLAN assignment allows a dynamic VLAN assignment for a specific user regardless of where the user is connected.
8. IEEE 802.1x and port security are provided to authenticate the port and manage network access for all MAC addresses, including that of the client.
9. Port-based ACLs for Layer 2 interfaces allow security policies to be applied on individual switch ports.
10. VLAN trunks can be created from any port, using either standard-based 802.1Q tagging.
11. 4000 VLAN IDs are supported.
12. IGMP snooping provides fast client joins and leaves of multicast streams and limits bandwidth intensive video traffic to only the requestors.
13. Shall support Uni-cast routing protocol RIP v2.
14. Shall support Protocol Independent Multicast (PIM).
15. 32-Gbps switching fabric.
16. Ethernet switches shall be as manufactured by Cisco or HP.

H. Edge Switches

1. Category 6 PoE Switch

a. IEEE 802.3af Power over Ethernet compliant
b. 2.68Mbps throughput
c. 3.6Gbps switching capacity
d. Broadcast storm control capability
e. 20MB RAM minimum
f. Auto MDI/MDI-X capability
g. 95W minimum PoE budget
h. 19” rack-mountable
i. UL listed
j. RoHS compliant
k. Telnet remote login capability
l. Non-blocking architecture
m. SNMP v1 and v2 compatibility
n. Wire speed performance
o. Rapid Spanning-Tree capability
p. WPA-PSK (AES) IEEE 802.1X RADIUS capability
q. VLAN tagging
r. Port mirroring
s. Link aggregation – LACP capability
t. SNTP capability
u. GVRP capability

I. Equipment Racks

1. ESC Contractor shall provide one (1) – 19" LCD monitor at each NVR rack location to be able to view NVR/VMC/VI server(s) display. Monitor shall be rack mounted.
2. ESC Contractor shall provide combination keyboard/monitor shelf at each NVR location.
3. ESC Contractor shall provide a mounted KVM Switch and all required cables and power supplies when more than one NVR is installed in a rack location. KVM capacity shall support connection of all NVRs in a rack location.
4. All IPVSS equipment is to be furnished with UPS backup per the UPS specification section. This is not including actual camera power. All 120 VAC camera circuits shall be connected to an emergency power circuit.
5. Top and bottom shall be 14-gauge steel, horizontal braces shall be 16-gauge steel welded to integral structural side panels of 16-gauge steel
6. Shall be fully enclosed and provided with front door, rear door, side panels and top panel with cooling fans.
7. Cooling fans shall be provided in a capacity to fully exhaust the heat dissipated by the equipment.
8. Rack shall come equipped with two pairs of 11-gauge steel rackrail with tapped 10-32 mounting holes in universal EIA spacing.
9. Contractor to provided 6 RU of blank space at the top to be enclosed using rack blank panels.
10. There shall be no spacing between components within the rack.
11. Equipment racks shall be Middle Atlantic Products or Atlas Soundolier.

J. Camera Poles

1. The heavy-duty pole is for exterior applications and is designed to be weatherproof against the outdoor environmental element effects of discoloration and as well shall be designed to meet or exceed the local requirements for wind load resistance. The installer shall be responsible for checking the local codes for compliance.
2. The poles staff shall be round and extruded from all new 6063 alloy aluminum tubing and heat-treated to produce a T6 temper. The pole shaft shall be 6" in diameter by 18 feet tall non-tapered and shall be of one-piece seamless construction. Shafts with seams welded or not will not be acceptable.

3. The pole shaft shall be continuously welded to a 12" base plate. The base plate shall be cast from A356 aluminum alloy and tempered to Aluminum Association T6 standards.
4. The anchor bolts shall be fabricated from structural quality, hot rolled carbon bar, having a minimum yield strength of 50,000 PSI. The anchor bolts shall be an "L" design and shall be galvanized.
5. An extruded handhole to provide for internal wiring shall be provided and shall have a cover with tamper-resistant security screws.
6. The unit shall be designed and manufactured to allow the conduit and wiring to be totally concealed and run within the unit.
7. The unit shall be finished in a standard dark bronze (DB) powder coating. Other finishes are available.
8. Concrete Mounting Base.
9. The pole shall mount to a round concrete base. The concrete base will be furnished under the General Construction Contract.
10. Poles shall be United Lighting Standards or approved equal.

K. History Video Storage:

1. The camera system shall store all video for all cameras for a minimum of 30 days. Provide calculations for review.

2.2 APPROVED PRODUCTS

A. Approved Cameras (Fixed Indoor/Outdoor, multi-sensor/Fisheye Cameras, License Plate Recognition Cameras, PTZ Cameras) Manufacturer(s)

1. Avigilon
2. Hanwha
3. Axis Communications
4. Or Approved Equal
    a. Substitution Limitations:
        1) Submit substitution requests in accordance with provisions of Section 01 60 00.
        2) Single manufacturer will provide, from a single source, a fully integrated surveillance system consisting of network cameras and the following components:
            a) Video Management System Analytics.
            b) Video Management System Interfaces.
            c) Video Surveillance Positioning Equipment.
            d) Video Surveillance Sensors.

B. Approved IPVSS Management Software and Network Video Recorder (NVR) Manufacturer(s)

1. Avigilon – Control Center 7
2. Hanwha – Wisenet WAVE
3. Axis Communications
4. Or Approved Equal
    a. Submit substitution requests in accordance with provisions of Section 01 60 00.
    b. Single manufacturer will provide, from a single source, a fully integrated surveillance system consisting of network video recorders and the following components:
        1) IP Video Cameras.
            a) Video Management System Interfaces.
            b) Video Surveillance Positioning Equipment.
            c) Video Surveillance Sensors.

C. Approved PoE Switch Manufacturer(s)

1. Cisco
2. Allied Telesis
3. HP – ProCurve Series
4. Or Approved Equal

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

A. Compliance: Comply with manufacturer's product data; including product technical bulletins, product catalog, installation instructions, submittal sketches or drawings, and product carton instructions for installation.

3.2 EXAMINATION

A. Site Verification of Conditions: Verify that related conditions, including equipment that has been previously installed under other sections, are acceptable for product installation in accordance with manufacturer's instructions.

B. All devices connected to equipment specified in this section shall bear the UL, cUL, or CSA label and comply with all applicable National Electrical Code (NEC) standards

3.3 PREPARATION

A. The ESC contractor shall develop custom software as required to affect the functions of the system as dictated by the drawings and Specifications.

B. The ESC contractor shall provide equipment cabinets for installation of the control equipment and cable terminations to the equipment.

C. All equipment related to the system shall be factory tested before shipment.

3.4 INSTALLATION

A. Contractor shall furnish all equipment, labor, system setup, and other services necessary for the proper installation of the products/system as indicated on the drawings and specified herein.

B. Install in accordance with manufacturer's handling and installation instructions.

C. Install in accordance with all local and pertaining codes and regulations.

D. The ESC shall install all equipment and systems. Subcontracting of equipment installation shall not be permitted.

E. Equipment shall be ready to use condition at end of installation.

F. Energize equipment in accordance with manufacturer's instructions.

3.5 PROTECTION AND CLEANING

A. Storage and Protection: Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer.

B. Touch up, repair, or replace damaged components before Substantial Completion.

C. Remove temporary tags, coverings, and construction debris from interior and exterior surfaces of equipment. Remove construction debris from equipment area and dispose of debris.

D. Clean integral air filters, heatsinks, grills, and fans before Substantial Completion and Commissioning Services.

3.6 WARRANTY

A. The ESC shall provide a single source warranty for all supplied equipment specified in this section to be free of defects in material and workmanship for a period of two (2) year from the date of substantial completion.

END OF SECTION

SECTION 28 13 00

ACCESS CONTROL SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Provide Card Access Control equipment as specified herein and as shown on the schedules and drawings. Installing contractor shall receive, place, connect, and mount all equipment specified in this Section per the manufacturer's instructions. Installing contractor shall furnish all hardware, wire, connectors, and other necessary items as required for a complete and functional Card Access Control system.

B. The terms "card" and "fob" may be used interchangeably throughout this specification document. Ensure that the provided system meets all Owner requirements regarding credential compatibility with cards, fobs, Bluetooth technology, etc.

C. Door hardware such as crashbars, handles, locking devices, escutcheons, hinges, kickplates, door assemblies, etc. are not included within the JSE Low Voltage scope of work. Coordinate provision of these components with the Owner's contracted Door hardware Consultant. Coordinate all access controlled door locations with the door hardware schedule to confirm exact locking mechanisms used, assemblies, surrounding conditions, etc.

D. Access control system shall fully integrate with the Fire Alarm system to ensure that access controlled doors are automatically unlocked during an alarm event. Follow all local codes and coordinate with the Fire Alarm system designer.

E. Coordinate with all local codes and the authority-having-jurisdiction regarding provisions of electronic egress devices and rules/regulations concerning access controlled doors in paths of egress to ensure full code-compliance.

F. Related Sections

1. 27 00 00 Communications
2. 27 15 13 Communications Copper Horizontal Cabling
3. 28 00 00 Electronic Security

1.2 REFERENCES

A. The General Conditions, Supplementary Conditions, and Division 1 Specifications shall apply to all work of this section.

B. Standards listed by reference, including revisions by issuing authority, form a part of this specification section to extent indicated. Standards listed are identified by issuing authority, authority abbreviation, designation number, title, or other designation established by issuing authority. Standards subsequently referenced herein are referred to by issuing authority abbreviation and standard designation.

C. Underwriter's Laboratories (UL)

1. UL 508 Industrial Control Equipment
2. NEC National Electrical Code (latest edition)

SECTION 28 13 00

ACCESS CONTROL SYSTEM

1.3 WORK INCLUDED

A. The Electronic Security Contractor shall furnish labor, equipment, and materials for the Access Control system including but not limited to:

1. Wiring
2. Equipment cabinets
3. Card reader data gathering panels, readers, system software, access control host computer, badging station and system software & programming
4. PoE (Power-over-Ethernet) power supplies and PoE switches

B. This Section consists of furnishing and installing a card access system as part of the Security Monitoring and Control System to include the following:

1. File Server
2. Remote Interfaces and Processors
3. Enrollment Terminal/Photo ID System
4. Administrative Terminal
5. Proximity/RFID Card Readers
6. RFID Long-Range Fob Readers
7. Keypads
8. PoE Power Supplies
9. PoE Switches
10. Logging Printer
11. Proximity/RFID Fobs
12. Vehicle Entry Gate RFID Transmitters and Receivers
13. Telephone Entry Stations
14. Video Intercom Stations
15. Request-to-Exit Pushbuttons (REX's)
16. Passive Infrared Request-to-Exit Motion Sensors (PIR's)

1.4 APPROVALS

A. General

1. Submittals shall be made in accordance with the General Provisions of these specifications.

B. Specific Requirements

1. Submit catalog cuts for all equipment and devices being furnished under this Section.
2. Submit a complete Access Control System riser diagram. Diagram shall include labeling of each reader and its corresponding head end equipment connection point and interconnecting wiring of all components.
3. Submit floor plan drawings showing location and mounting of each card reader.

1.5 DESCRIPTION

A. The Access Control System shall provide a means to control and monitor access at specified doors throughout the facility.

B. Each system shall consist of proximity/RFID-type Card/Fob sensor devices, status input devices, output control devices, control processor(s), interface modules, file server, remote terminals, printers, software and programming.

C. Hardware and software to interface the Access Control System with the Touch Screen and/or Graphic Control Panel Systems.

D. An enrollment terminal for programming the card access system security functions shall be provided for the system. No other terminal shall be capable of entering or modifying the card access system. The enrollment station shall be capable of having a color photo ID badging system as an integral component.

E. The software shall run on a Microsoft Windows operating system.

F. The contractor shall provide the latest version of operating system at the end of the project. At closeout and at the end of the warrantee period, the latest version of software shall be loaded onto the operating system. In addition, a backup copy of the software shall be turned over to the Owner.

G. The software shall be user programmable. All source codes, passwords, and any other codes shall be turned over to the Owner such that the Owner can have access to any and all parts of the software and any other components. The intent is for the Owner to have complete access to all components of the system he is purchasing without the need of a maintenance contract. Although an after-warrantee maintenance contract may be considered by the Owner. See additional requirements herein and in the Security General specification sections.

H. System shall be equipped for expansion to remote sites by the addition of an interface card and modem.

I. The new system shall have a 6 TB hard drive minimum.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Acceptable Manufacturers

1. Head end equipment/software –Gallagher, LenelS2 – OnGuard Series, Software House, Avigilon
2. Proximity/RFID Readers – Gallagher, HID, DoorKing, Avigilon
3. Keypads – Gallagher, HID, DoorKing, Avigilon
4. PoE Power Supplies – Altronix, Securitron
5. PoE Switches – Cisco, Allied Telesis, HP – ProCurve Series
6. Proximity/RFID Cards/Fobs – Gallagher, HID, DoorKing, Avigilon
7. Vehicle Gate UHF RFID Long Range Readers – Gallagher/Nedap, HID, DoorKing, ButterflyMX, LiftMaster, AWID, TransCore
8. Vehicle Exit and Entry/Safety Loop Detectors and Loop Wiring – DoorKing, LiftMaster
9. Parking Exit (Car Coming) Warning Signs/System – PASS Signs
10. Telephone Entry Stations – ButterflyMX, Linear, DoorKing, Avigilon
11. Video Intercom Stations – ButterflyMX, Aiphone, Avigilon
12. Request-to-Exit Pushbuttons (REX's) – Honeywell, Securitron, Alarm Controls, Dynalock
13. Passive Infrared Request-to-Exit Motion Sensors (PIR's) – Honeywell, Gallagher, Schlage, Bosch
14. Or Approved Equals

B. Scope

SECTION 28 13 00

ACCESS CONTROL SYSTEM

1. This specification outlines the requirements for a single local controller up to a centrally controlled distributed processing and centrally programmed monitored access control system capable of running on an industry standard computer with the manufacturer's priority software.

C. Computer Hardware Requirements

1. The computer shall be configured at a minimum in a following manner.
2. Furnish and commission a centrally located host computer and software as described following:
   a. IBM PC 100% compatible computer, Intel Core i7-3770 CPU at 3.4 MHz
   b. 64 GB of RAM
   c. 6 TB Hard Drive
   d. DVD +/- RW Optical Drive
   e. 25" LCD Color Display
   f. Printer port and line printer for event printing
   g. Two RS232 and one RS485 serial communication ports
   h. Microsoft compatible bus mouse
   i. Surge protector
   j. Uninterruptable Power Supply

D. Computer Software Requirements

1. The computer shall include the following software:
   a. Windows 10, minimum
   b. Access control system software

E. Computer Software Features

1. The following features shall be provided for the computer:
   a. Programming of users and system configuration information across multiple systems.
   b. Password protected, multilevel operator programming capabilities.
   c. Issue of commands to any controller from the computer, like momentarily unlocking a door.
   d. Storage to hard disk of all event transactions.
   e. Archive to floppy or tape of stored event transactions for long term storage.
   f. User customizable reports generated from stored event transactions.
   g. User, door and alarm input English text names appear on screen, printer and reports.
   h. Host operator action logging to disk.
   i. Customizable event and report print.
   j. The system shall provide for a minimum of 1,000 users.
   k. The system shall provide for a maximum of 10,000 users.

F. Host Computer to Controller Communication Protocols

1. Communications between the computer and the controller shall be accomplished utilizing a standard 10/100 TCIP connection.

G. Maximum System Wide Capacities

1. The following shall be the maximum system-wide capacities. Actual numbers shall be dependent upon mix of controllers that make up the system.
   a. 32,640 readers
   b. 261,120 monitor alarm inputs
   c. 4032 control relay inputs

d. 2,040 controllers which can be any combination of access control; alarm monitoring and relay controllers

H. Head End Component

1. Controller
   a. There shall be three primary types of controllers: access control, alarm monitoring and relay control.
   b. The controller board shall be microprocessor-based incorporating ROM, on board battery backup RAM and a clock calendar. The ROM shall be modularly upgradeable in the field for enhancements to systems features. All power connections to the controller board shall be protected by fuses. All wiring connections to the controller board shall be screw terminals. Each door connection shall consist of terminals for two readers, one 5 amp rated form c dry output relay for lock control and one input for monitoring and status switch, a request to exit device and tamper switch. There shall be status indicator lights for active relays as well as diagnostic indicator lights to aid in system trouble shooting.
   c. There shall be dedicated alarm output relays for external reporting of the following conditions: Alarm, Duress, Tamper, Trouble.
   d. The controller enclosure shall be a NEMA style metal cabinet designed for surface mounting. It shall have a tamper proof removable hinge door with a high security lock.
   e. The controller shall have an internal power supply that will accept 60 Hz 120V AC. The primary site of the power supply shall be protected with a fuse. The power supply shall provide 28V DC power to the controller board, internal battery charger, scrambling keypads (if applicable), selected card readers and reader interface boards.

I. Standby Batter

1. The controller shall have an internal standby battery that is capable of running the system during AC power interruption which shall be automatically recharged by a charging circuit incorporated into the controller board. This standby battery shall be capable of operating the system for 4 hours minimum.

J. Expansion Options

1. A maximum of 5 expansion boards can be installed in each controller. An interface board is included with each controller.
2. Alarm Inputs:
   a. Each controller shall be capable of accepting up to 16 additional supervised alarm inputs in increments of 4 and/or 8. Alarm expansion boards shall be mounted in the controller cabinet and connect to the controller board by an expansion bus cable.

3. Relay Outputs:
   a. The two access control and one alarm monitoring controller shall be capable of accepting up to 32 additional relay outputs in increments of 8. The outputs shall be used for control applications other than standard door access such as elevator floor control, local door annunciator, HVAC interface etc. The relay expansion boards shall be mounted in the control room cabinet and connect to the controller board via an expansion bus cable.

4. Code Database:
   a. The controller shall be capable of expanding the code database up to a minimum of 50,000 users with the addition of a memory expansion board. The board shall be mounted in the controller cabinet connected to the controller board via an expansion bus cable.

5. Event Transaction Buffer:

a. The controller shall be capable of expanding the event transaction buffer up to a maximum 3500 alarms with in each board. The board shall be mounted in the controller cabinet and connected to the controller board via an expansion bus cable.

6. Serial Communication Interface:
   a. The controller shall be capable of interfacing to a serial printer for event transaction printing or to a serial terminal for programming with the addition of a serial interface board.

K. Proximity/RFID Readers

1. The controller shall accept all of the reader technologies concurrently.
   a. Proximity/RFID

2. The readers can be used for access control, alarm management and or/relay control and shall be capable of being used in combined operation with keypad and any other reader technology to operate as a dual technology reader where two valid IDs are required.
3. Proximity Card Readers:
   a. The controller shall be capable of using proximity/RFID card readers that output a standard Wiegand data format. The readers can have a short or long read range and be unidirectional or bi-directional.
   b. Provide a slim line reader for builders store front doors with 2" jambs.

L. Vehicle Gate UHF RFID Long Range Readers

1. UHF RFID long-range readers shall allow for vehicle entry via vehicle/windshield-mounted tags/barcodes.
   a. Alternatively, if and when required or approved by Owner, single click open functionality may be utilized for resident vehicle entry.

M. Vehicle Exit and Entry/Safety Loop Detectors and Loop Wiring

1. Loop detectors shall be installed at vehicle entries and exits to ensure that gates, barrier arms, etc. do not close until vehicles have safely cleared and to allow free egress, where applicable.

N. Parking Exit (Car Coming) Warning Signs/System

1. Illuminated, audible warning signs shall be located where parking/garage entries and exits are in close proximity to sidewalks or other pedestrian pathways to ensure safety of pedestrians, bicyclists, etc. or as required by Owner.

O. PoE Power Supplies

1. Each access controlled door shall be provided with a PoE power supply, meeting the following minimum performance requirements:
   a. Input: Category 6
   b. Output: Power-over-Ethernet to devices
   c. Output Current: 1A
   d. Battery Backup
   e. UL Class 2 Listed

2. Multiple controlled doors, in close proximity to one another, may connect to the same Power Supply dependent upon available outputs and manufacturer’s recommended electrical specifications.

P. PoE Switches

1. Category 6 PoE Switch
   a. IEEE 802.3af Power over Ethernet compliant
   b. 2.68Mbps throughput
   c. 3.6Gbps switching capacity
   d. Broadcast storm control capability
   e. 20MB RAM minimum
   f. Auto MDI/MDI-X capability
   g. 95W minimum PoE budget
   h. 19” rack-mountable
   i. UL listed
   j. RoHS compliant
   k. Telnet remote login capability
   l. Non-blocking architecture
   m. SNMP v1 and v2 compatibility
   n. Wirespeed performance
   o. Rapid Spanning-Tree capability
   p. WPA-PSK (AES) IEEE 802.1X RADIUS capability
   q. VLAN tagging
   r. Port mirroring
   s. Link aggregation – LACP capability
   t. SNTP capability
   u. GVRP capability

Q. Telephone Entry Systems

1. Telephone Entry stations shall meet the following minimum performance requirements:
   a. Up to 1,000 4-digit entry codes
   b. Up to 8,000 device codes
   c. Single line LCD display
   d. Elevator control support
   e. PC programmable
   f. Vandal-resistant
   g. 12VAC
   h. Compatible with Cellular, VoIP, Wireless, or POTS connectivity methods
   i. Compatible with Wiegand devices

2. Telephone Entry stations shall be home run to the MDF Room via Category 6 cabling.

R. Video Intercom Systems

1. Video Intercom door stations shall meet the following minimum performance requirements:
   a. Color video CMOS camera with audio intercom
   b. Pan-Tilt-Zoom (PTZ) camera lens
   c. 2-way hands-free communication
   d. Call button to initiate calls to master station
   e. LED illuminator for low-light conditions

2. Video Intercom door stations shall connect back to the master station (and any sub-master stations as required) via 2-cnductor wiring, per manufacturer recommendations.
3. Wiring distances shall not exceed 330’.

S. Access Control Features

1. The controller shall have the following access control features at a minimum:
    a. Restrict access by time of day, day of week, door or holiday.
    b. Momentary unlock of door.
    c. Relock of door by code, card or time zone.
    d. Door status monitoring shall allow for door forced monitoring, door open too long monitoring, door opened too long while door is unlocked, auto relock of door when open or closed.
    e. Request exit alarms and/or unlocks.
    f. Two person requirement per door.
    g. Passback control including use restriction based on status.
    h. Absentee rule limits.
    i. Temporary day limits.
    j. Occupancy counting minimum/maximum limits.
    k. Coordinate with the Owner for any other operating features required.

T. Hot Redundant CPU & Software

1. Provide a complete redundant CPU equipped with all software and hardware necessary, hot and on line, ready to take over in case of failure of the primary CPU operating system.
2. Provide a second workstation with complete operating software. Coordinate location with the Owner.

U. Fobs and Users:

1. Provide 1000 Fobs.
2. Each User shall require only a single Fob for access control.
3. Where multiple systems are utilized on the property (i.e. conventional hard-wired access control in addition to battery-operated controlled doors), coordinate to ensure single Fob compatibility between systems.

V. Pedestals

1. Provide mounting pedestals, per manufacturer recommendations, for all Proximity/RFID Readers, Telephone Entry stations, and/or Video Intercom stations located at vehicle entry gates.
2. Pedestals shall be of steel construction.
3. Style of pedestal and number of arms/face plates shall be as noted in the Drawings and Details.

W. Request-to-Exit Pushbuttons (REX's) and Passive Infrared Request-to-Exit Motion Sensors (PIR's)

1. Coordinate provision of electronic exit devices with the Door Hardware Consultant to ensure compatibility with the door's hardware set, locking devices, etc.
2. Coordinate aesthetics and mounting of electronic exit devices with the Architect prior to installation; provide slimline pushbuttons where possible.
3. Provide all electronic exit devices per applicable codes.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

A. Compliance: Comply with manufacturer's product data; including product technical bulletins, product catalog, installation instructions, submittal sketches or drawings, and product carton instructions for installation.

3.2 EXAMINATION

A. Site Verification of Conditions: Verify that related conditions, including equipment that has been previously installed under other sections, are acceptable for product installation in accordance with manufacturer's instructions.

B. All devices connected to equipment specified in this section shall bear the UL, cUL, or CSA label and comply with all applicable National Electrical Code (NEC) standards.

3.3 PREPARATION

A. The electronic security contractor shall develop custom software as required to affect the functions of the system as dictated by the drawings and Specifications.

B. The electronic security contractor shall provide equipment cabinets for installation of the control equipment and cable terminations to the equipment.

C. All equipment related to the system shall be factory tested before shipment.

3.4 INSTALLATION

A. Contractor shall furnish all equipment, labor, system setup, and other services necessary for the proper installation of the products/system as indicated on the drawings and specified herein.

B. Install in accordance with manufacturer's handling and installation instructions.

C. Install in accordance with all local and pertaining codes and regulations.

D. All equipment and systems shall be installed by the ESC. Subcontracting of equipment installation shall not be permitted.

E. Equipment shall be ready to use condition at end of installation.

F. Energize equipment in accordance with manufacturer's instructions.

3.5 PROTECTION AND CLEANING

A. Storage and Protection: Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer.

B. Touch up, repair, or replace damaged components before Substantial Completion.

C. Remove temporary tags, coverings, and construction debris from interior and exterior surfaces of equipment. Remove construction debris from equipment area and dispose of debris.

D. Clean integral air filters, heatsinks, grills, and fans before Substantial Completion and Commissioning Services.

3.6 WARRANTY

A. The ESC shall provide a single source warranty for all supplied equipment specified in this section to be free of defects in material and workmanship for a period of two (2) years from the date of substantial completion.

END OF SECTION

SECTION 28 30 00

TWO-WAY EMERGENCY COMMUNICATION SYSTEM

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable requirements of Section 26 00 00 - Electrical General shall be considered a part of this section and shall have the same force as if printed herein in full.

B. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and/or on the Drawings.

1.2 WORK INCLUDED

A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

B. The work shall include, but not be limited to, the following:

1. Furnish and install communication base system, call boxes, graphics, labeling and all associated wiring.

1.3 QUALITY ASSURANCE

A. Coordination: Coordinate installation with architectural and structural features, equipment installed under other sections of the Specifications.

B. Components and installation shall be in accordance with the requirements of the International Building Code, NFPA, and ADAAG.

1.4 SHOP DRAWINGS

A. Shop drawings shall be submitted and shall contain the following:

1. Specification sheet/sheets of technical data on each hardware component
2. Specification sheet(s) on wiring to be utilized
3. One-line schematic riser diagram made specifically for this job
4. Calculation for sizing batteries and power supplies
5. Sequence of operation for the entire system
6. Verification of central supervising station (UL Certified)
7. Equipment and service warranty
8. Scaled floor plans showing device locations and wire routing

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

A. Approved Two-Way Communication System Manufacturer

1. Rath Area of Refuge
2. Approved Equal

2.2 SYSTEM COMPONENTS

A. The Base Station shall be installed in location shown on the drawings, and shall have the following components:

1. Stainless steel or powder-coated steel housing, red coil cord emergency Handset, 120vac powered, with battery back-up power for 4 hours operation of any call box and base station.
2. Audible and visual indicator that a call box has been activated.
3. 24vac power supply model capable of supplying power to a minimum of 40 call boxes.

B. Each Call Box shall be installed in location shown on the drawings, and shall have the following features:

1. Must comply with Americans with Disabilities Act (ADA)
2. Hands-free speakerphone with an LED to indicate status of call
3. Programmable for specific location message of the Call Box. This allows rescue personnel to know the location of the activated Call Box.
4. Braille faceplate located no higher than 48" for front reach and 54" for side reach above ground level to ensure conformance with the ADA requirements.

2.3 SYSTEM FEATURES

A. Operational Communication Features

1. Call Box shall be hands-free operable and be a push-button-once to talk system. Once the button has been pushed, the Call Box will call the Base Station. If no answer at the Base Station, it will automatically call preprogrammed emergency numbers. The Call Box must be capable of being programmed with up to 5 emergency numbers to activate two-way off-site person-to-person voice communications.
2. Call Box shall have Location Message capability. Call Box must have a minimum 18 second recordable message capability, programmable to play 1 or 2 times. Call Box shall notify called party of the location of the call upon being received at the emergency dispatch center.
3. Call Box shall be capable of allowing the called party to replay the Location Message if necessary to ensure an understanding of the caller location.
4. Once call has been made (button pushed), the call can be terminated only by the called party.
5. Call Box must have a red LED that will light up upon push of the button. The light shall be a solid color when the Call Box is activated, and will flash when call has been answered.
6. Call Box must be capable of being programmed and reprogrammed on-site and remotely.
7. Operating temperature of call box shall be between -40 deg. F to 150 deg. F.
8. Call Box shall have EEPROM memory to protect programming.

B. Graphics and Labeling

1. Base Station shall have appropriate wording to indicate the location of each call box, located adjacent to the LED associated with each call box.
2. Call Box graphics must include “Help Phone,” international phone symbol and raised Braille lettering.

PART 3 - EXECUTION

3.1 MONITORING

A. Contractor shall coordinate with the owner to arrange for an off-site monitoring agency associated with this communication system.

3.2 CABLING

A. Cabling for two-way communication system shall meet the applicable requirements for pathway survivability. Cabling installation shall consist of one or more of the following:

1. 2-hour fire-rated circuit integrity (CI) cable
2. 2-hour fire-rated cable system
3. 2-hour fire-rated enclosure or protected area

3.3 TESTING

A. Prior to completion, contractor shall test the functionality of all call boxes, both for connection to the base station, as well as for successful communication with off-site monitoring agency.

3.4 WARRANTY

A. System shall be warranted for a period of three years.

END OF SECTION

SECTION 28 31 11

FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section covers the complete installation of a new automatic fire alarm system, as well as necessary materials, labor, calibration, testing and training.

B. The scope of work described in these Specifications and/or indicated on the Drawings shall be designed/engineered by the Contractor as a Delegated Design Responsibility. All professional engineering services related to the Fire Alarm system shall be delegated to the Contractor.

C. The complete installation shall be in compliance with NFPA 70, 72, 101 (Life Safety Code) and NEC Article 760. The installation shall also comply with ASME A17.1, state and local ordinances, and the Americans with Disabilities Act (Public Law 101-336).

D. All equipment supplied shall be listed for the purpose and area in which it is used and installed in accordance with any instructions included in its listing.

E. All equipment must be new and bear the UL (Underwriters Laboratories Inc.) Label.

1.2 SHOP DRAWINGS

A. Fire alarm shop drawings shall contain the following:

1. Specification sheet(s) of technical data on each hardware component
2. Specification sheet(s) on wiring to be utilized
3. One-line schematic riser diagram made specifically for this job
4. Calculation for sizing batteries and power supplies
5. Sequence of operation for the entire system
6. Copy of vendor’s NICET fire alarm certificate (level III or higher)
7. Verification of central supervising station (UL Certified)
8. Equipment and service warranty
9. Scaled floor plans showing fire alarm device locations/wire routing, air sampling pipe layout for VESDA smoke detection systems and cable layout/routing for linear heat detectors.

1.3 ACCEPTABLE MANUFACTURERS

A. Products of the following manufacturers which comply with these specifications are acceptable:

1. Honeywell – Notifier/Gamewell-FCI/Farenhyt/Xtralis
2. Siemens
3. E.S.T.
4. Johnson Controls – SimplexGrinnell

1.4 STORAGE AND HANDLING

A. Smoke detectors shall be covered with plastic wrapping if installed prior to the completion of painting, sanding and other work producing dust, etc.

B. The fire alarm control panel(s) shall not be installed until its designated room has been completely painted and cleaned.

PART 2 - PRODUCTS

2.1 CONTROL PANEL/SYSTEM DESCRIPTION

A. The fire alarm system shall be an electrically supervised, power limited, low voltage (24 VDC), non-coded, multiplexed, fully analog, addressable system. The fire alarm control panel shall be of modular design for ease of future system addition or modification (up to 20% additional capacity).

B. The control panel shall provide system status via an 80-character liquid crystal display and shall also have the following features:

1. Power “ON” Light Emitting Diode (LED)
2. System Reset Switch
3. System Alarm LED
4. System Trouble LED
5. Alarm Silence Display
6. Trouble Silence Display
7. Control panel shall be lockable.
8. Normally open and normally closed sets of contacts for control of remote equipment/devices.

C. Batteries shall be mounted in space provided in the fire alarm control panel. Control panel shall include automatic charging circuit to maintain battery/batteries in charged condition. Batteries may be lead acid or nicad; charging circuit shall match battery type.

D. The battery/batteries shall have sufficient ampere-hour capacity to operate the system under normal supervisory conditions with A.C. power disconnected for 24 hours, and at the end of that period to operate all alarm notification appliances for 5 minutes. For calculation purposes, all audible devices shall be tapped at a minimum of one (1) watt.

E. The system shall operate from one (1) 20-ampere, single-phase, 3-wire 120 V.A.C. circuit. The circuit breaker shall be labeled “Fire Alarm Circuit Control.”

F. The fire alarm system shall respond to a fire emergency as follows:

1. Smoke damper control and automatic shutdown of HVAC air systems shall occur upon activation of respective duct smoke detector.
2. Automatic audible/visual notification (via horns/strobes) shall be provided upon activation of a flow switch, manual station, or area smoke detector.
3. Pre-recorded voice message capability shall be provided for automatic transmission to building occupants during alarm conditions. A standard evacuation message shall be provided under this Contract. The message player must be capable of transmitting a customized message of up to 3 minutes long. A self-contained speaker will be provided to allow testing of the message without disturbing the occupants of the facility. The system shall be configured to allow selective voice paging. If any manual control switches are activated, the control panel operator shall be able to make announcements via a push-to-talk paging microphone over the preselected speaker circuits (where applicable).
4. Signal output to the UL Listed central station (for fire system reporting) shall be installed in accordance to the project specifications and drawings.
    a. Basic Performance:
        1) The Communicator will communicate to GSM networks in the area including 2G, 3G and 4G. 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.

2) Supervision of communication path shall be monitored and automatically tested per the NFPA requirements listed below based on local NFPA adoptions:
NFPA72 2010 GSM Single Path (cellular only) 5 minutes
NFPA72 2013 GSM Single Path (cellular only) 1 hour
3) Diagnostic LEDs: Signal strength and status indications.
4) All circuits shall be power-limited, per UL864 requirements.
5) In areas where the GSM network signal strength is poor or not allowed by the AHJ, a D.A.C.T. communication device (or similar UL Listed "fire" device) shall be provided in lieu of cellular communicator. Provide and install 3/4" conduit from the panel to the main telephone backboard.

5. Smoke door release (where applicable) shall occur generally throughout the entire facility.
6. Tamper switch operation shall cause a supervisory signal to indicate audibly and visually at the control panel.
7. Activation of elevator lobby or elevator equipment room/space smoke detector shall cause immediate, non-stop return of all respective elevators to designated discharge level. Provide and install 3/4" conduit from control panel to elevator controller(s).
8. Controls for unlocking stairwell doors simultaneously.
9. Upon activation of heat detectors located in elevator machine rooms/spaces and hoistways, there shall be a delay in the activation of the power shunt trip. This delay shall be the time necessary for the elevator cab to travel from the top of the hoistway to the lowest recall level.

G. Supervision

1. Fire alarm pathways shall be Class B.
2. Pathway survivability for notification appliances shall be as follows:
   a. Pathways shall be protected from the point at which they exit the control unit until they enter the evacuation signaling zone they serve and shall meet survivability requirements Level 0 or 1.
3. Each independently supervised circuit shall include a discrete panel readout to indicate disarrangement conditions per circuit.
4. Power failures, opens, or grounds shall be audibly and visually indicated at the control panel and the remote annunciator (where applicable). A green "power on" LED shall be displayed continuously while incoming power is present.
5. Power wiring to sprinkler pipe heat tracing shall be supervised by fire alarm system.
6. Fire Pump:
   a. Fire pump status shall be displayed for the following conditions:
      1) Power failure
      2) Pump operation
      3) Phase reversal
   b. Fire pump normal power availability, normal source phase reversal, normal source loss of phase and run status shall be monitored. Loss of normal power, phase reversal and loss of phase shall annunciate as trouble. Fire pump running shall annunciate as a supervisory alarm.
7. Fire alarm system shall electrically supervise the signal boosters and batteries of the Emergency Responder Radio Coverage System (where applicable).

H. Provide remote annunciator panel with 80-character liquid crystal display, audible signal and alarm/trouble lights.

I. Underground Signaling Line Circuits

1. All underground signaling line circuits (SLC) routed exterior to building shall be fiber optic cabling. Cabling shall be installed in conduit with tracer wire.

J. Transient Voltage Surge Suppression

1. Approved manufacturer/model: DITEK DTK-TSS1.
2. Provide all necessary components to provide complete protection of the control panel, data, signal, and dialer circuits/connections.
3. Surge protection shall be provided for any copper NAC, IDC and SLC circuits which are installed underground outside of a building.
4. All underground pathways entering the building to be protected by surge protectors on both ends and properly grounded.
5. A listed surge protective device shall be installed on the supply side of the fire alarm control panel.
6. Modules shall be mounted in NEMA 12 steel enclosure adjacent to FACP.

2.3 FIELD DEVICES

A. Manual Stations: Semi-flush, addressable, double action type. Station shall be constructed of high impact red polycarbonate.

B. Area Smoke Detectors: Smoke detectors shall be of the analog, addressable, photoelectric type. A pulsed diode pilot lamp, visible from the floor, shall be provided to indicate alarm condition or component failure. Diode pilot lamp may be pulsed diode type for normal and steady for alarm trouble indication. Detectors shall be self-supervising for component failure as well as line failure. Detector failure or removal of detector shall initiate (zone) trouble signal. Detector shall be capable of monitoring 900 square feet of unobstructed area with spacing not to exceed 30 feet on center. Smoke detectors shall be ceiling mounted and shall be interconnected into alarm system to function in same manner as the manual station. Detectors shall report analog level of smoke/dirt to panel.

C. Duct Smoke Detectors: Detectors shall be of the analog, addressable, photoelectric type. The unit shall consist of a detector and an air sampling assembly housed in a casting designed for duct mounting. The sampling tubes shall extend completely across the duct. Detectors shall report analog level of smoke/dirt to panel. Where detector LEDs are concealed, not easily observable, or greater than 10' above floor, detectors shall have remote LED alarm indicators in a nearby observable location for alarm identification. Each LED shall be labeled to identify location of duct smoke detector.

D. Air sampling-type detector (VESDA): Detector shall be installed outside the elevator shaft/pit with its sampling tube installed to sample the air within the shaft. The system consists of the following:
1. Highly sensitive, laser-based smoke detector using aspirated air sampling and is connected to sampling pipe(s). It shall be provided with a sample pipe inlet, internal flow monitoring, smoke detection and a facility for exhaust pipe connection.
2. Reset, disable, test and fault determination functions will be available via the field service access door. The detector shall have control switches for Reset, Disable, Test and restricted access switches for Alarm Setup and Flow Setup.
3. Detector shall have individual illuminated indicators for the following:
   a. Four alarm levels (Alert, Action, Fire1 & Fire 2)
   b. Fault
   c. Power & Disabled
   d. Alarm Setup and Flow Setup.
4. Detector shall incorporate an ultrasonic flow sensor in the pipe inlet port for airflow monitoring purposes.
5. Aspirator shall be a purpose-designed aspirator assembly.
6. Sampling pipe shall be smooth bore. Piping with an outside diameter (OD) of 25mm or 1.05” and internal diameter (ID) of 21mm or ¾” should be used.
7. Pipe material should be suitable for the environment in which it is installed.

8. Pipe shall be identified as Air Sampling/Aspirating Smoke Detector Pipe (or similar wording) along its entire length at regular intervals.
9. All pipes should be supported at not less than 1.5m (5ft) centers.
10. Detector status information is communicated on the detector display and via interface is communicated to the fire alarm system.

E. Audible/Visual Devices: Audible/visual devices shall be horns with flashing visual appliances with the word “FIRE” written on the lens. The horns shall produce at least 15 dBa above ambient noise level. Audible and visual devices (including the combination device) shall utilize a 4" electrical backbox. Visual devices shall be multi-candela, field-selectable, with a constant flash rate of one (1) flash per second. The device color shall be white.

F. Any audible device installed in a sleeping room, including living rooms, shall have a low-frequency sounder approved for fire protective service, and shall be listed to UL 464. The device shall be powered from a notification appliance circuit output and shall operate on nominal 12 or 24 volts (includes fire alarm panels with built in sync). All notification appliances shall be backward compatible.

G. Any visual device in a sleeping area shall be minimum 110 candela, unless noted otherwise.

H. Addressable relays shall be provided as required to accomplish all mechanical systems and other related control functions.

I. Addressable input monitoring devices shall be provided as required to monitor existing water flow, tamper switch, and other devices.

J. Heat detectors shall be addressable, fixed temperature type rated at 135 degrees F, unless noted otherwise on drawings. Where heat detectors are used to shut down elevator power prior to sprinkler operation, the detector must have a faster response time than the sprinkler head and must be mounted within 2 feet of each sprinkler head. Power required to activate shunt-trip breakers for elevator motors shall be monitored via supervisory wiring to the fire alarm control panel. Heat detectors shall be installed in elevator machine rooms/spaces where sprinklers are present, to activate shunt trip devices for power to elevator motors.

K. Linear Heat Detectors shall be installed inside elevator shafts/pits where sprinklers are present. Location of the detector (interface module) shall be outside of the shaft/pit in an accessible location. Coordinate the location of the linear heat detector cable within the shaft/pit.

1. The heat sensitive cable shall be a continuous run of spot heat detectors capable of sensing heat anywhere along its length and initiating an alarm once its fixed activation temperature is reached.
2. The linear heat detector interface module is a detection control module that acts as an interface between a fire alarm control panel and the Linear Heat Detectors. The module provides one supervised detection circuit that may be field wired for either Class A (Style D) or Class B (Style B) service. Each module shall contain the following:
    a. (1) green “Power” LED indicator
    b. (1) red “Alarm” LED indicator
    c. (1) yellow “Fault” LED indicator.
    d. (1) set of Form C (SPDT) Alarm contacts and (1) set of normally energized Form C (SPDT) Fault contacts shall also be provided to interface the unit to the host fire alarm panel.
    e. The module shall be capable of Modbus over RS-485 communications providing module status information.

L. CO Detectors: The detector shall have the ability to detect Carbon Monoxide gases in compliance with UL 2075. The detector shall automatically include drift compensation of CO cell. Provide a 24 Volt with Integral Sounder base connected to the SLC Addressable Circuit. Sounder shall be capable of providing a Temp 4 pattern for CO Alarm indication. The sounder bases shall synchronize with its native system.

M. Photoelectric CO detectors: The detector shall have dual functionality to detect Carbon Monoxide gases in compliance with UL 2075 use photoelectric principle to measure smoke density in accordance with UL268 7th edition. The detector shall automatically include drift compensation of CO cell. Provide a 24 Volt with Integral Sounder base connected to the SLC Addressable Circuit. Sounder shall be capable of providing a Temp 4 pattern for CO Alarm indication and a Temp 3 for Fire conditions. The sounder bases shall synchronize with its native system.

N. Fire phone jacks shall mount on stainless steel single gang plates labeled in red “Fire Emergency Phone.”

O. Smoke Detectors with Integral Sounder: Detectors in each sleeping room and living room shall be addressable, system-connected with built-in evacuation horn and power-on indicator. Where more than one is installed in a suite or unit, activation of one detector shall trigger all horns in that suite or unit.

P. Monitoring of remote fire protection valves on site (if applicable) shall be accomplished via fire alarm system connection.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall obtain approval from Owner as to the final and exact location of each control panel and remote annunciator prior to installation.

B. All wiring shall be suitably protected from damage. Wiring shall be routed within conduit where installed in the following areas:

1. Underground
2. Damp and wet locations
3. Where exposed on interior walls
4. For all input and output signal wiring for smoke exhaust (including stairwell pressurization) equipment

C. All wiring installed exposed within a plenum shall be UL Listed accordingly. Plenum rated cable shall be tied to the building structure at approximately 6'-0" on center using cable ties.

D. Conduit sleeves with bushings shall be installed for fire alarm cabling that passes through walls and floor assemblies. Seal the opening around the conduit and the hole in the conduit with a UL Listed fire rated sealant as required.

E. All detection and control wiring to mechanical smoke control systems shall be fully enclosed within continuous raceways.

F. Provide necessary programming to accomplish the indicated system operation and control functions.

G. All conduit, control wiring, power wiring, relays, and other equipment and devices required to form a complete and operational system shall be provided as part of this Contract.

H. All wiring requirements for shielding certain conductors from others or routing in separate raceways shall be as recommended by the manufacturer.

I. The Fire Alarm Contractor shall coordinate all electrical branch circuit identification requirements listed in NFPA 72, Chapter 10 with the Electrical Contractor.

3.2 WARRANTY

A. Equipment, materials, workmanship and system performance incorporated into the work shall be guaranteed for a period of one (1) year from the time the Owner receives beneficial use of the fire alarm system and the acceptance tests herein specified have been satisfactorily completed. Any defects due to faulty materials, methods or installation or workmanship within this period shall be promptly repaired or replaced.

B. Vendor shall provide pricing for system inspections for a period of four (4) additional years after the initial 12-month warranty as a bid alternate to the Owner. Provide inspections per NFPA 72 and NFPA 101.

C. Spare Parts: Provide the following spare equipment items to the Owner upon project completion:

1. Addressable modules: 2
2. Smoke detectors: 2
3. Manual stations: 2
4. Duct mounted smoke detectors: 1
5. Audible/visual devices: 4

3.3 TESTING AND CERTIFICATION

A. Testing and certification of the life safety system per NFPA 72 shall be as required by the Fire Marshal and Engineer. The Contractor shall be responsible for identifying the required testing, coordinate scheduling, and conducting the test necessary to achieve occupancy certification, and assurance of complete system operation. The Contractor shall submit proof of complete system operation signed by the Fire Marshal to Engineer and Owner.

B. Contractor shall notify the Owner's representative in writing that the Owner is responsible for hiring a monitoring agency for remote supervision of the fire alarm system.

END OF SECTION